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Investigative Program
Intermountain Region

April 1, 1933

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REPORT OF THE

INTERMOUNTAIN FOREST AND RANGE EXPERIMENT STATION

AND

REGIONAL INVESTIGATIVE COMMITTE

INTERMOUNTAIN REGION

1932-1933

CONTENTS

REGIONAL INVESTIGATIVE

COMMITTEE MEETING

1933

Regional Investigative Committee Report

The regular meeting to consider the investigative program for 1933 for the Intermountain region was held in the Regional Office at Ogden, Utah, March 2, 3 and 4. Present at this meeting were the Regional Forester, the Assistant Regional Foresters in charge of Forest Management, Operation, Range Management, and Public Relations and Lands; Supervisors C. J. Olsen of the Nevada National Forest, G. B. Mains of the Boise National Forest, W. B. Rice of the Payette National Forest, C. E. Favre of the Wyoming National Forest, C. B. Arentson of the Cache National Forest, A. G. Nord of the Wasatch National Forest; Assistant Forest Supervisors Geo. C. Larson of the Uinta National Forest and E. E. McKee of the Challis National Forest; various assistants from the branches of the Regional Office and several men in Ogden on detail from the national forests, the technical staff of the Intermountain Forest and Range Experiment Station and the following representatives from outside the Forest Service: Professors T. G. Taylor, R. J. Becraft, G. D. Clyde and R. W. Bailey of the Utah State Agricultural College; Paul M. Dunn, Extension Service, Utah State Agricultural College; S. M. Jorgenson and J. A. Hooper, president and secretary of the Utah Woolgrowers, J. M. Macfarlane and Thomas Redmond, president and secretary of the Utah Cattle & Horse Growers' Association, J. L. Nielson, president of the Manti Woolgrowers' Association, F. R. Marshall, secretary of the National Woolgrowers, J. M. Cooper of the U. S. Sheep Experiment Station; Harry Shellworth of the Boise-Payette Lumber Company; Dr. Geo. R. Hill, agriculturist of the American Smelting &

Refining Company, and R. L. Turpin of the Utah State Game Department. R. H. Rutledge, Regional Forester, served as chairman and C. L. Forsling of the Intermountain Forest & Range Experiment Station acted as assistant chairman.

The meeting this year was conducted along the same lines as in the preceding years. A brief summary covering results obtained during the past year was presented and discussed for each of the projects and general consideration was given to plans for the coming year. Special consideration was given to whether or not three days' time for so large a group for the discussion of results of research work is justified. The consensus of opinion is that these meetings afford the chief opportunity for administrative forest officers and visitors to keep in touch with progress and to make suggestions for work to be done in forest research, and that therefore the time is fully justified. The one shortcoming of these large meetings is that frequently it is not possible to give as much consideration to future plans as may be justified.

One of the special benefits derived this year was the frank discussion and offering of suggestions by woolgrower representatives on the character of work that should be undertaken on the study of the management of desert shrub range.

General Progress of Work

The Copeland Report and the special study of conditions on the Public Domain in the region drew heavily upon the time of the personnel of both the station and the region. Practically all of the time of

three fourths of the personnel of the station and several men from the Regional Office spent most of the period from the middle of August to the holidays on these special projects. It is felt, however, that the time thus taken from the regular projects on these two jobs was well justified by the value of the information obtained. A good deal of the time of the Director was used on special field trips and investigations in connection with watershed protection, particularly with reference to the low-value forest land in central Idaho.

There follows herewith a brief discussion of progress and plans of the various station projects and in administrative investigations by the Regional Office.

REPORT OF THE

INTERMOUNTAIN FOREST AND RANGE EXPERIMENT STATION

Station Personnel

C. L. Forsling - Director

Walter E. Mann)
Marguerite A. Israelson) - Clerks
Blanche Hoxsie)

Forest Management

Methods of cutting ponderosa pine:

Chas. A. Connaughton
E. L. Mowat

Range Management

Utah Plateau Summer Range:

Raymond Price
E. W. Nelson

Artificial Reseeding:

Raymond Price
E. W. Nelson

(Sweet clover investigations in cooperation with Bureau of Plant Industry, Office of Forage Crops, Russell A. Oakley, in charge, L. W. Kephart.)

Sagebrush-bunchgrass Range (Spring-Fall):

George Stewart
G. D. Pickford

(Upper Snake River Plains in cooperation with Bureau of Animal Industry, U. S. Sheep Experiment Station, Dubois, Idaho, J. M. Cooper, Supt. in charge.)

Desert Shrub (Semidesert Winter Ranges):

George Stewart
S. S. Hutchings

Bunchgrass on Granitic Soils:

Geo. W. Craddock, Jr.
Kenneth Pearse

Erosion and Streamflow

C. L. Forsling - In Charge.

Bunchgrass type, granitic soils, Idaho:

Geo. W. Craddock, Jr.
Kenneth Pearse

Utah Erosion:

Milo H. Deming

Colorado River Erosion Survey:

Milo H. Deming

(In cooperation with Region 2, Allen S. Peck, Regional Forester and Jay Higgins, Forest Supervisor.)

Biological Investigations in cooperation with U. S. Biological Survey:

_____(vacant)

FOREST MANAGEMENT (Silvical Research)

Methods of Cutting Ponderosa Pine

Silvical investigations were initiated by the Intermountain Station in the Fiscal year 1931. The work now consists of one major project - methods of cutting ponderosa pine, which includes also two subprojects, namely, (1) a study of the influence of forest cover as may result from different methods of cutting upon snow storage and rate of snow recession in the spring to be concluded in 1933, and a study in cooperation with the University of Idaho of natural reproduction following different methods of cutting as affected by lesser vegetation and related factors. A third line of work, less directly related to methods of cutting but undertaken as a matter of expediency and largely completed in 1932, is an intensive study of fire damage in ponderosa pine, initiated during the past season. Another line of work to be undertaken for a brief period during 1933 is the acquiring of growth and yield data for evenaged stands of ponderosa pine, for a project headed by the Pacific Northwest Station.

In addition the Station is assisting Region 4 in an advisory capacity, in fire studies and in securing better practices in administrative forest research plots. The analysis of past fire records and lightning storms has now been taken over entirely by Mr. Shank of the Regional Office, but assistance was given during the past year on the measurement of fire hazard by means of wood cylinders and duff hygrometers.

Growth of Ponderosa Pine on Permanent Plots

The last annual report outlined the nature and location of permanent plots. The analysis and machine compilation of the records from

20 five-acre permanent plots in virgin and cut-over stands of ponderosa pine, all of which were measured in 1931, have been carried forward, and preliminary information on growth in virgin stands is now available. These data show that there is still considerable increment in near mature stands and that there is no loss but actually some gain in not cutting such stands immediately. The following figures are based on a total of 16 uncut plots, aggregating 74.17 acres, established on the Big Pine Creek and Poorman Creek drainages of the Fayette National Forest in 1913, 1914, and 1915.

Stand and Growth Per Acre - Virgin Ponderosa Pine

Species	Original Stand (1914)	Gross Growth Per Year		Mortality Per Year		Net Growth Per Year		Present Stand (1931)
	bd. ft.	bd. ft.	%	bd. ft.	%	bd. ft.	%	bd. ft.
Pine	18,640	189	1.0	96	0.5	93	0.5	20,220
Fir	5,570	92	1.6	45	0.8	47	0.8	6,380
Total	24,210	281	1.2	141	0.6	140	0.6	26,600

These average figures fail to tell the whole story — many interesting and significant facts are revealed only by a study of the detailed records of growth and losses in terms of number of trees, diameter, basal area, and cubic feet, as well as board feet, for the various plots, aspects, species, and tree sizes and classes, and for the two growth periods (1914-1918 and 1918-1931). A few examples may be mentioned:

1. The number of living trees over 3.6" in diameter has increased 31 per cent in 17 years. Although the original numbers of the two species were about the same, the net increase in number of pines has been four times that of the firs.

2. In percentage rate of growth, Douglas fir has exceeded ponderosa pine in spite of heavy losses; the difference in terms of net cubic-foot growth is less than that shown above for board foot growth, being for pine 0.48 per cent, and for fir 0.65 per cent.

3. The difference as to the number of years required to grow one inch in D.B.H. in the different tree classes is as follows:

Tree Class (Dunning)	Years Required to Grow 1" D.B.H.	
	Pine	Fir
1	5.06	5.30
2	7.16	7.54
3	7.13	7.64
4	11.38	9.84
5	13.02	10.86
6	14.41	13.48
7	20.04	--

4. The gross growth per acre per year from 1914 to 1918 averaged 60.6 cubic feet as compared with 47.1 cubic feet from 1918 to 1931. Most of this difference is in pine (Douglas fir averaged nearly the same for the two periods) and is believed to be due more to drought in the latter period than to a slowing up of growth with approach toward maturity.

Growth on Cut-over Areas

Similar growth figures were obtained and are being compiled for three 5-acre plots which were selectively cut in 1913. To make most effective use of this information on growth on these and other permanent plots, the Station is making a critical comparison of conditions on the plots with conditions over more extensive cut-over and virgin forest areas.

A study of four Forest Service timber sale areas and one private cut-over tract representing cuttings ranging from 6 to 25 years ago, and several sites and degrees of cutting and totaling 3,000 acres, was made last fall. It is hoped that this inventory will furnish a connecting link between permanent plot data and the more extensive administrative surveys of cut-over areas. The method was essentially a 5 per cent line-plot cruise, in which, however, the record of each cruise plot was nearly as intensive as that of a permanent plot. Increment borings were made as a check on diameter growth.

New Plots for Methods-of-Cutting Studies

Two new permanent plots to study methods of cutting were established this year on the Moores Creek drainage near Idaho City, on private land cut-over in the fall of 1931 under a policy of "economic selection" or "high-grading." It is in contrast with past private cutting practice in this region, where the land was stripped clean of every tree that could possibly be called merchantable. Approximately 80 per cent of an original volume of 23,850 bd. ft. per acre was removed from the plots, leaving a present stand of 4,700 bd. ft. per acre, together with a fair stand of smaller trees. Utilization of felled trees was low, and no slash disposal whatever was attempted.

Plant Succession and Reproduction

The study of natural reproduction as affected by associated vegetation and related factors in the central Idaho ponderosa pine type was carried forward under the same cooperative arrangement with the University of Idaho as in 1931. Intensive quadrat studies have been

made in two virgin forest and three cut-over areas in Boise Basin and the Payette South Fork drainage. The virgin forest studies indicated the importance of competition for soil moisture as the controlling factor in establishment and growth of advance reproduction. Subsequent reproduction was scarce on the cut-over area; only 112 such seedlings were found on about 20 acres on the Clear Creek Forest Service timber sale near Pioneerville, Idaho. Of these, 83 per cent had germinated within two years after logging. The location of these seedlings is significant -- the favorite place was beside stumps; numbers were found around the edges of slash pile burns, and beside logs, sticks, and skid trails; they were least abundant where the lesser vegetation had not been disturbed and litter was thin or absent.

Snow Storage and Recession

The study of the influence of different forms of forest cover, such as might result from various cutting methods in ponderosa pine, upon the total winter accumulation of snow and its rate of melting, aimed to give at least a partial answer to the question raised by irrigationists as to the effect of cutting timber upon the total yield of water and time of flow from forested watersheds, indicates that brush cover or young tree growth affords conditions more favorable for the accumulation of snowfall but result in more rapid melting of snow in the spring as compared to stands of mature timber. It should not be overlooked that this study does not take into account the complete disposal of the snowfall, which, if done, might modify the results. The following table shows the

character of forest and ground cover on five plots and gives a summary of the results of 1931 and 1932:

Plot Cover	Amount of Snow Storage: Inches of Water		Comparison of stored water using plot 1 as 100% each year		Delay in Melting Due to Cover: No. of days later than plot 1	
	1931	1932	1931	1932	1931	1932
1. Bare ground	9.95	17.52	100.00	100.00	--	--
2. Sagebrush	10.00	18.06	100.00+	103.08	0	1
3. Mature ponderosa pine with dense reproduction	6.35	13.60	63.50	77.63	10	7
4. Mature ponderosa pine - no undergrowth	7.25	14.26	72.50	81.39	6	3
5. Young second growth (30-yr.old reproduction)	8.75	16.77	87.50	95.72	4	7

The high spreading crowns of large trees particularly are effective in intercepting and dissipating snowfall before it reaches the ground. There was little difference between bare ground and sagebrush in effect on total accumulation. The amount of snow intercepted by trees appears to be more or less of a constant quantity per season rather than directly proportional to total snowfall.

Rate of snow melting was retarded by high forest cover. It required from 7 to 10 days longer for the snow to disappear under the mature pine stand than on bare ground.

A progress report describing method of study and giving results and preliminary conclusions will be published this year.

Fire Damage Study

The object of the fire damage study is to determine losses in timber, forage, and watershed values caused by fire and subsequent recovery in the ponderosa pine type. One very significant purpose of the study is to determine a reliable base for fire damage appraisals in this type, which have been notably difficult and uncertain in the past, both as to immediate and ultimate effects.

During 1932, 5,120 acres of virgin national forest timber land and 5,330 acres of private cut-over land were cruised on a 10 per cent basis by the line-plot system and detailed information was recorded in code form for 4,176 quarter-acre plots.on the area burned by the Quartzburg fire of August, 1931. This fire burned approximately 45,000 acres in the ponderosa pine type, including virgin timber stands, private cut-over land, and large second-growth areas.

A series of 10 permanent sample plots, totaling 21 acres, and vegetation and reproduction transects totaling 126 chains in length were established.to supplement the cruise information and determine further losses and changes that take place during the years after a fire. These will be examined annually for a few years and regular remeasurements made at intervals of 5 years.

Major results and conclusions await machine compilation and analysis of the data, but a few of the incidental facts and figures are of interest.

1. Fire has reduced the stocking by living trees to an average of 18.4 per cent of that before the fire, as determined by the "stocked quadrat" system.

2. Advance reproduction was largely destroyed, but new pine seedlings (of 1932 germination)were fairly abundant in some of the partially burned stands. The number of such pine seedlings averaged 238 per acre, Douglas fir, 18 per acre, on the transects within permanent sample plots. Many of them appeared quite vigorous, giving promise of fair survival.

3. Seedlings of snowbrush (Ceanothus velutinus) were very numerous, appearing on 65 per cent of the 369 quadrats examined.

4. Very few porcupines, rabbits, grouse, and deer were observed during the cruise, but ground rodents appeared to have survived the fire and were about as abundant as on unburned areas. A trial of direct seeding on the burn failed because of consumption of seed by rodents.

5. The absence of bark beetles during the first year after this severe fire is notable.

6. The hottest and most disastrous fire seemed to occur on north slopes, apparently due to the denser growth of trees and brush, more debris, and a larger proportion of Douglas fir.

Plans for 1933

1. The analysis of growth on virgin and cut-over permanent plots in the ponderosa pine type will be completed and progress reports prepared. The data for the cut-over inventory will be compiled and correlated with growth records of plots. Results of these studies should give a more accurate picture of growth conditions in virgin and cut-over stands, should make possible better predictions of growth, and should finally lead to improved marking and cutting practices in ponderosa pine.

2. The Pine Creek portion of the newly established Boise Basin Experimental Forest will be logged in 1933. Plans for work on this area include (1) a 100 per cent cruise of all or a portion of the area; (2) the establishment and remeasurement of extensive permanent reproduction transects; (3) the establishment of series of permanent sample plots to apply and study distinct methods of cutting (as outlined in last annual report); and (4) initiation of slash disposal studies.

3. The study of natural reproduction as affected by associated vegetation and related factors will be carried through another season if the University of Idaho continues to cooperate on the same basis.

4. The annual measurements of snow storage and melting in relation to forest cover will be made for the last time on the snow recession plots in the spring of 1933. The three years' records will be compiled and summarized in a final report.

5. The compilation and analysis of the fire damage study data will be completed and reported upon. The only additional field work planned for the coming year is the examination of permanent plots and remeasurement of transects.

6. As this Station's share in the inter-regional study of growth and yield in evenaged stands of ponderosa pine, measurements will be made on about 50 temporary sample plots in selected stands throughout Region 4.

7. Occasional assistance will be given the Regional Office with the aim of standardizing and making most effective the work on administrative plots and fuel moisture (fire hazard) measurement.

RANGE MANAGEMENT

Summer Range - Wasatch Plateau (Great Basin Branch)

The management of summer range project of the Wasatch Plateau region was initiated in 1912 at the Great Basin Branch Station and has been carried continuously since that time. During this period numerous phases of the project have been completed and the results published and also new phases have been subsequently undertaken. The project now stands with field work in some of the latter phases completed and the results are being analyzed for publication; others are completed and are awaiting analysis for publication, and still others are being carried forward necessitating further study.

The regular field work in this project was handled by Raymond Price, Jr. Range Examiner, and two summer field assistants. E. W. Nelson, Asst. Range Examiner spent practically all of his time in the office on compilation and analysis of the climate and plant growth and plant development (period study) subprojects. In addition, Miss Sylvia Griswold spent the field season as field assistant in further work in the seed habits study and Dr. E. C. McCarty of the Riverside Junior College, Riverside, California, spent the field season collecting samples in the plant nutrition study which were later analyzed by him at Riverside Junior College.

The broad project logically breaks down into a number of subprojects or lines of work all relating to the management of summer range. These, including recent combinations, are as follows:

1. The effect of climate on plant growth.

2. Natural revegetation as a means of improvement and maintenance of the range.

3. The degree of utilization as a factor in range management.

4. Vegetational readiness and the length of the grazing season as a factor in range management. (Field work is largely completed, the remnants have been combined with climate and plant growth subproject and the separate subproject as been dropped.)

5. The influence of season, frequency and degree of harvesting on the productivity, revegetation and vigor of range vegetation.

6. The role of seeding habits of range plants. (Combined with natural revegetation subproject in 1933.)

7. The role of rodents in range improvement and maintenance. (Combined with natural revegetation subproject in 1933.)

Climate and Plant Growth

A better understanding of the climatic conditions which influence the spring growth of pasture vegetation on western mountain ranges that will be helpful both in the maintenance and improvement of the range and in the better care of livestock is afforded by the results of a study now in progress of the fluctuations in the seasonal development of range plants in different years in three altitudinal zones on the Wasatch Plateau in Utah. The results emphasize that range grazing plans must provide for a measure of elasticity and cannot be made to conform to a rigid calendar of operations. Earlier investigations showed that the time when grazing in the spring begins in relation to the stage of

development of the range plants is of critical importance with respect to maintaining the condition of both the range and the livestock. The present study which is still to be completed, deals with the variations in the beginning and subsequent development of range forage growth from year to year, the principal causes of the variations, their influence on range use and the need for a method of judging conditions in advance of the beginning of the annual grazing period. The knowledge obtained is useful in planning both the management of the range and the care of the livestock.

The seasonal development of the vegetation from inception of growth to maturity on mountain slopes where there is a measurable accumulation of snow throughout the winter, may be divided into three main stages; namely, production of leafage, production of flower stalks and flowering and seed ripening to plant maturity. In the first stage air temperatures appear to be the chief influencing factor, in the second it is rainfall, and in the third rainfall and temperatures play approximately equal parts.

The inception of growth of one of the more important grasses for example is found to vary as much as 18 to 30 days between "early" and "late" years; the date when flower stalks are first in evidence, which appears to be a fairly safe date to begin grazing, may vary as much as 27 days under some conditions between early and late years. The date of seed ripening, a vital factor in planning deferred and rotation grazing has been found to vary between early and late years as much as 27 days in the lower mountain elevations, 16 days at the middle elevations and

21 days at the higher elevations. It is also shown that there is a delay in inception of growth in the spring with increase in altitude in mountain slopes; this delay varies from 11 to 14 days on the average for each 1,000 feet increase in elevation. However, there is a tendency for growth at the higher elevations to "catch up" during the earlier stages, with the growth at the lower elevations so that 8 to 10 days less time after inception of growth is required for vegetation to reach a condition ready for grazing at the higher elevations as compared to the lower mountain slopes.

It is found that the inception of plant growth in the spring on mountain grazing lands is materially influenced by the quantity of snow that has accumulated during the winter and lies on the ground when the spring melt begins and by the rate at which the snow layer melts. With a relatively light layer of snow and favorable temperatures, the snow disappears rapidly and plant growth begins early. Other things being equal, a heavy layer of snow results in a later start of plant growth. The snow layer naturally is lighter at the lower elevations so that less rise in temperature is necessary to remove it and the melting period is correspondingly short and plant growth begins earlier as compared to the higher elevations. A longer period of favorable temperatures or higher temperatures or both are necessary to remove the snow layer at the higher elevations.

On the other hand, plant growth is more rapid once it starts, at the higher elevations, than on the lower mountain slopes. This is accounted for by the fact that the lighter layer of snow at the lower

elevations disappears and plant growth starts before the spring weather has settled and frequently cold snaps slow up the early growth. At the higher elevations the deeper layer of snow prevents the start of growth until the spring weather is relatively well settled and fewer cold snaps subsequently interfere to retard development of the vegetation.

Indications are that proper time to graze the range may be predicted a few days to several weeks in advance through the use of temperature records. A study of hourly temperatures during the early spring show that the percentage of hours of temperatures below freezing is a better indicator of the rate of growth than the percentage of hours between 32° F. and 40° F. or the percentage of hours above 40° F.

Plans for F.Y. 1934

Procuring records of the more important climatic factors during the growing season in the three vegetation zones of the Wasatch Plateau is essential for integrating the climatic factor in all of the range studies. In addition forage yield data are being obtained on 8 yield plots and growth rate data on 12 important range plant species to determine the influence of the climatic factor on forage yield and grazing capacity; sufficient season's data are now available on the latter phase for the preparation of a fair analysis of this problem. Field work will be continued since long time records are essential to fully interpret the vagaries of the climatic factor. The vegetational readiness and length of growing season phase of this subproject, formerly carried as a subproject, is being compiled and analyzed by E. W. Nelson.

Range improvement and maintenance by natural revegetation of principal forage species. Most of the experimental plots, including 76 quadrats, 71 major plots, and 7 intensively mapped areas, which have been established since 1914 in the three major vegetation zones of the Wasatch Plateau and so located as to show the changes of the native forage cover on range lands under varying degrees of depletion, erosion, and intensity of grazing, were remapped in 1932. Sufficient data are available for a progress report. However, these plots should be maintained indefinitely.

Grazing surveys were made for the first time of six large experimental pastures previously established. A number of new plots also were established and recorded following the rebuilding of fences which involved the enlargement of several old enclosures.

Plans for F. Y. 1934

Continued studies on this project are very essential to fully determine the ecological changes involved. Important data have been collected over a period of 15 years and should be continued. Thirty-six quadrats and 32 major plots located at key stations throughout the three major zones will be remapped and re-estimated.

The role of seed habits in range plants in natural revegetation. The results of a study of the germination, under 17 conditions of 55 of the important range plants on the Wasatch Plateau have been analyzed and the report is nearing completion. Delay by Miss Griswold in completion of the report has been occasioned by attention to her teaching duties.

Plans for F. Y. 1934

The report will be completed.

A study of the proper degree of utilization of range lands. Field work in this subproject was completed in 1932 and the data are awaiting analysis and preparation of report.

Plans for F. Y. 1934

The preliminary analysis of this project will be undertaken.

The influence of season, frequency, and degree of harvesting on the productivity, revegetation, and vigor of range forage plants.

a. Empirical clipping and grazing phase.

During the office season there has been pushed toward conclusion the preliminary analysis of the data from the clipping of two grasses and one weed species carried on under 16 systems of harvesting over the period 1923 to 1930 inclusive. The results with six systems under actual grazing carried on from 1923 to 1930 inclusive, on a grass-weed range have still to be analyzed. Yield data for three methods of treatment with two shrubs have been obtained during the past six years.

b. Nutrition phase.

Preliminary results in the year's work in the study of the effect of different seasons and frequencies of clipping on the nutrition (carbohydrate metabolism) of three important range plants suggest the value of this method of study in affording a better understanding of the physiological response of range plants to different methods of treatment, as a guide to developing improved systems of grazing. The study is being conducted by Dr. E. C. McCarty of Riverside Junior College, who is employed as a field assistant during the field season and makes the chemical

analyses at Riverside Junior College during the winter. It is planned to carry the study through 1933 and 1934.

Preliminary analyses of results obtained with Bromus polyanthus show that the carbohydrate food level in the roots and stem bases fluctuates inversely with vegetative growth. There is a heavy drain of stored food at the inception of growth which is followed by a rise sufficient to maintain the growth rate. Vegetative growth, including flower stalk and seed formation, is completed before the storage of reserve carbohydrates occurs in the roots. Root growth, which takes place after maximum height growth has been reached, and secondary shoot growth tend to hold in check the accumulation of reserve food in the roots. When these growth processes are completed the food storage rate is greatly increased for the remainder of the season.

As shown in the following table the sum total of reducing sugars, sucrose, starch and hemicellulose, for convenience called carbohydrate plant foods, present in the roots at the close of the growing season is less as the date of clipping approaches the interval of maximum food accumulation. In other words, as the date of clipping or grazing nears or correponds to the date of food accumulation, the sum total of plant food present in the roots at the close of the season is proportionately less. It appears that clipping during the time of active shoot growth not only prevents food storage but also prolongs vegetative growth which draws upon the food already stored.

Plot No.	Method	Sum total of carbohydrate food present in roots at close of season. (percent)	
		Clipping*	Grazing
Q	Control plot, not clipped	15.45	16.10
K	Clipped once 15 days after growth started, or when 4" high.	13.50	
L	Clipped once 40 days after growth started, or when heads were high in boot.	13.50	
M	Clipped 75 days after growth started, or when seed is in milk.	10.20	
N	Clipped 100 days after growth started, or when seed is ripe.	8.17	14.26
O	Clipped once 15 days after growth started, and at 15-day intervals throughout the remainder of the growing season.	5.10	9.05

*Based on weight of sample.

The results obtained from plots under actual grazing practices were somewhat higher than the results in the clipped series, although the control plots in both cases agree very favorably. The difference in results of the methods lies in the fact that clipping represents 100 percent utilization on the clipped date whereas the grazed plots represent moderate utilization over a longer period. For example, plot N of the clipped series was 100 per cent utilized by complete clipping at time of seed maturity whereas the deferred plot of the grazed series was utilized gradually over a period of approximately 20 days beginning at time of seed maturity. Enough herbage was left during these 20 days of high rate of storage on the deferred plot to lay back practically a normal food supply in the roots.

Plans for F. Y. 1934

Further compilations and analysis of the empirical clipping and grazing phase will be pushed with a view of completing a report. The second years' study will be completed on the nutrition phase.

Range Management of Bunchgrass Range on Granitic Soils

Activities on this project during 1932 have been confined to (1) charting and measuring the vegetation on a small number of quadrats and sample plots in order to provide data for correlation of plant growth and yearly fluctuations in climate, and (2), an investigation, in cooperation with Liter Spence of the University of Idaho, on the nature of the root systems of important range species.

In all, 24 quadrats and 35 major plots distributed among ten of the study areas described in the last report were remeasured and recharted during the past field season. Plots were laid out in one new enclosure established to include almost all of the drainage area at the head of a small but typical gully. All of the plot data accumulated during the past three field seasons have been compiled and checked and are ready for preliminary analysis, but this will be delayed until after the data collected during the coming season are available.

Cursory examination of the accumulated data indicates that annual variations in density in response to climatic fluctuations are considerably less in the climax grassland (bunchgrass type) than in the depleted types where there has been an invasion of annuals and other ruderal species. If this is substantiated in the final analysis, it will

further show the desirability of reestablishing the bunchgrass type on depleted areas for the control of erosion as well as for the statilization of the grazing industry.

The root studies initiated this year were made in comparatively deep colluvial soil on a south facing slope in Long Gulch drainage at an elevation of about 4,600 feet. At this site examinations were made of the root systems of five specimens each of twelve prominent herbaceous species as follows:

(c) Agropyron inerme	(c) Lupinus ornatus
(c) Poa sandbergii	(c) Phacelia heterophylla
(1) Bromus tectorum	(c) Chaenactis douglasii
(c) Balsamorhiza sagittata	(c) Achillea lanulosa
(c) Eriogonum umbellatum	(1) Gayophytum diffusum
(1) Lactuca scariola	(1) Collomia linearis

Of these the species marked (c) are found in more or less abundance in the climax grass phase and those marked (1) are prominent invaders where the Agropyron has been depleted.

Although the study has only been started, interesting and unexpected results have already been obtained. Under the conditions of soils, climate, and exposure under which the investigations have so far been made, very extensive root systems are developed. A Balsamorhiza sagittata plant was excavated whose roots reached a depth of 12 feet and ramified the soil for a distance of three to five feet in all directions from the center of the plant. The larger roots of this species are well supplied with laterals, but since these are not abundant in the upper ten to twelve inches, this species has a rather low soil protection value as far as its root system is concerned. The roots of Lupinus ornatus and Phacelia

heterophylla reach to depths of about five feet, but are extremely straggly, little branched, except at their lowest extremities, and can have little effect in soil binding. However, the extent to which the roots of both of these species penetrate raw hard granite in which even the iron had not begun to oxidize is remarkable, and they are doubtless one of the most potent biological forces which hasten rock decay and soil formation. Chaenactis douglasii and all of the annual weeds excavated can be considered together on the basis of their root systems just as they were considered together in the study of plant succession. All of them have little more than a single straight tap root which grows directly downward to a depth of two or three feet. The soil protection value of root systems of this type is obviously very low.

On the other extreme, the one annual grass and the two perennial grasses so far excavated appear to have the most valuable type of root systems for erosion control. These all have very fibrous and well branched roots which bind the soil immediately around the base of the plant into a firm mat which can be broken up only with difficulty. Although the perennial grass species have tougher and more extensive roots than the annual cheatgrass, their value as soil-holding plants is lessened to some extent because of their more scattered habit of growth as compared with that of cheatgrass which often grows as dense as 1,000 plants per square meter. On the other hand the value of cheatgrass is offset to some extent by the lowering of densities in dry years.

As an example of the unexpected applications of the root study project mention may be made of the possible use of root systems to determine the extent of past erosion on various sites on the watershed. It was found that in the case of several of the long-lived herbaceous species examined, the upper portion of the root system invariably showed an offset toward the downhill side, as though the root crown as the result of sheet erosion, gravitational creep, or trampling by game and livestock had moved downhill since the plant had become established. This offset usually involves only the portion of the root in the upper six inches of soil and indicates a movement of the root crown of as much as a foot. It is especially characteristic of Lupinus ornatus, and Phacelia heterophylla. Further study of this phenomenon on a number of species and on contrasting sites should provide valuable indications of past erosion conditions.

Plans for F. Y. 1934

During the coming field season, effort on this project will be concentrated on the plot studies and quadrats to measure the extent of reestablishment of vegetation and the reclamation of gullies under different degrees of depletion, erosion and grazing use. After these data are compiled a preliminary analysis of all of the plot data accumulated to date can be attempted. Work on the root study will consist of excavation of the same species worked on last year, but on a different site, probably on a north slope. It is planned to continue work on this project until the root systems of all of the important herbaceous and shrub species on varying sites of the watershed have been examined. This will afford a

basis for deciding which are the most important species to maintain for erosion control purposes insofar as root systems are concerned.

During the coming spring, measurement of depth and water content at the three snow courses already established will be made. In addition, observations directed toward obtaining a reliable idea of the amount and nature of precipitation on the watershed will be begun. Between 20 and 25 rain gauges will be installed at cooperative stations well distributed over the area. The precipitation data thus obtained will permit a study of the local variability of destructive summer storms, provide a better means of estimating the total precipitation that falls on the watershed, and be of use in the study of climate in relation to plant growth.

Management Sagebrush-Wheatgrass (Spring-Fall) Range

Open, unreserved sagebrush-wheatgrass range lands in southern Idaho, northern Nevada and Utah have declined approximately 72 percent from their original grazing capacity as the result of unrestricted grazing. Perennial grasses, which were originally the principal herbaceous forage, have been depleted approximately 72 percent. These grasses have been replaced to a great extent by inferior forage plants as evidenced by the fact that the total plant cover of these range lands has been reduced only 28 percent. Correlation between decreased grazing capacity and perennial grass depletion is extraordinarily high, indicating that depletion of these grasses by improper grazing practices has been a key factor on spring-fall range lands of the Intermountain region.

The above figures are based on a study of 139 localities representing in excess of 1,500 plots. This study was made by two investigators during the period from 1930 to 1932 inclusive, and is incorporated in a report on public domain conditions made by the Intermountain Forest and Range Experiment Station in 1932.

Deliberate spring overgrazing by sheep in experimental pastures on spring-fall range at the U. S. Sheep Experiment Station at Dubois, Idaho has produced approximately the same amount of grazing capacity losses and perennial grass depletion that has occurred on the unreserved public domain lands of the Intermountain region. Nine years of controlled experimental grazing tests at the Sheep Station have shown that heavy fall utilization by sheep year after year, when preceded by light or by no spring utilization, is not injurious to the range. This indicates that

the range is most susceptible to grazing injury during the spring growing season.

During the year the vegetation was mapped and quadrats established on 8 small "natural" areas of approximately 10 acres each which were fenced in 1931. These areas are distributed over the spring-fall range in Utah and will serve as valuable check plots in all future studies on this type of range. The plots in these areas will be remapped approximately every five years.

The results of experimental grazing in paddocks to determine the effect of season of use have been completed and are being prepared for publication.

A series of plots were established to compare changes in vegetation after burning sagebrush range where the sagebrush has become so dense and tall as to interfere with grazing.

Plans for 1933

The work in this project during 1933 will be confined to the study of methods of grazing in twelve 80-acre paddocks at the U. S. Sheep Experiment Station and to the burning over of some sagebrush range in cooperation with the Fremont County Woolgrowers Association. The latter line of work was carried through its initial stages in 1932 except for the actual burning which will be done in 1933. The manuscript of the first 8 years of results at the U. S. Sheep Experiment Station will be completed in the spring of 1933. A revision of the working plan for the Sheep Experiment Station grazing projects is practically completed.

Management of Desert-Shrub Range

Sheep losses on the winter desert-shrub ranges of western Utah and central Nevada exceeded 20 percent during the winter of 1931-1932. The lamb crop in 1932 was only 48 percent as compared to 78 percent in 1931 and 81 percent in 1930. To overcome these unprofitable conditions in the range industry and reduce this waste of human energy and natural resources is the objective of research on these lands.

A study of sheep outfits owned in Fountain Green, Utah, representing 93,750 head showed that supplemental feeding as a general practice was first initiated on the winter ranges of western Utah during the winter of 1928-1929, after a season of drought, when approximately 1,200,000 pounds of corn were fed. Even greater but unknown amounts were fed during the winter of 1931-32 after a more severe drought, but in spite of this increased feeding heavy losses were sustained in old ewes and yearlings.

These excessive losses, poor lamb crops, and increased costs of production can be directly attributed to (a) climatic influences, and (b) range depletion caused by heavy uncontrolled and unrestricted grazing.

Basic information is needed as a foundation upon which to build range management that will better meet variable climatic conditions. The total precipitation on the desert ranges of eastern Nevada and western Utah in 1932 approximated 6 inches. At Baker, Nevada the total precipitation was 5.75 inches while at Ibex, Utah, 33 miles east, it was 6.11 inches. Marked variation in localized areas were found in summer storms, both as to occurrence and amount. Observations of single storms

show that they were very localized, for example one station received in a single storm 1.20 inches precipitation while at another station 5 miles distant, no precipitation occurred. Forage growth is from two to three times greater during seasons of high rainfall than in seasons of drought, and often one to three times greater on localized areas of heavy rainfall during a single season. Seed crops of range forage plants are produced only during seasons of favorable precipitation. The forage with seeds is of much higher quality than that grown in years of drought when little or no seed is produced.

The precipitation in winter seems to be somewhat uniform, but the amount of snowfall varies considerably from one year to another. During winters when the snow is deep and crusted, it is extremely difficult for the sheep to obtain feed, especially following seasons of poor forage production. When this combination of circumstances arises supplemental feeding is imperative to prevent excessive losses. Relative growth in a drought year and in one of somewhat greater precipitation is shown in Table 1.

Table 1. Plant growth in a year of drought (1931) compared with growth during a year of somewhat greater precipitation (1932).

Location	1931	1932	% Increase or decrease
	White Sage		
1. Snake Valley	5.64	7.54	+ 34
2. Antelope Valley	2.78	6.44	+ 132
3. Antelope Valley	4.89	7.05	+ 44
Average	4.44	7.01	+ 58
	Shadscale		
1. Snake Valley	6.48	5.76	- 11
2. Antelope Valley	3.51	6.59	+ 108
3. Cedar Pass	10.25*	7.24	-
4. Cedar Pass	6.06	7.94	+ 31
Average	5.35	6.76	+ 26

* Flooded in 1931 due to heavy localized rains. Not normal as to amount of growth.

Condition of Range

The loss in productivity on millions of acres of desert-shrub ranges is shown by data obtained on 1,308 plots in western Utah and central Nevada which compare each of 47 grazed areas with similar adjacent areas moderately grazed or completely protected for many years. These data show an average decline of 58 percent in grazing capacity, 37 percent in total vegetative cover, and 40 percent in perennial grasses. The decrease in grazing capacity is the result of the depletion of perennial grasses and the more valuable browse. In a goodly

number of the cases, plant species of inferior forage value have increased in quantity sufficient to compensate for the decrease in plant cover caused by the destruction of the better forage plants, leaving the present vegetative cover as great or greater than before, although much inferior in forage quality.

The better and more accessible areas, especially those nearer water, have been the most seriously damaged. Many of these are practically denuded. In Reese River Valley, Nevada, where watering places are rather uniformly and somewhat closely located, the grazing capacity has been reduced 80 to 90 percent. In Wah Wah Valley, Utah, where watering places are somewhat greater distances apart, the grazing capacity has been reduced 70 to 80 percent, and in Snake Valley, Utah, where grazing has been confined to periods when snow is available, the decline has been only 20 to 30 percent.

Experienced sheepmen who use these desert ranges report that many of the better forage plants have been eliminated by overgrazing on large areas of range. It is their opinion, based on long experience, that sheep become adapted to grazing plants that are supposed to be less palatable, thus changing their eating habits. In early days grass, according to the reports, black sage (Artemisia nova), bud sage (Artemisia spinescens), mixed with some shadscale (Atriplex confertifolia) were sought as the most desirable range, and the sheep passed by such plants as big sage and many others. Now big sage (Artemisia tridentata) is eaten to a great extent, although it was formerly thought worthless.

Thus the process of attrition of the range is going on taking first the better then the poorer species until eventually little of value will be left unless better range management is developed.

Invasion

Lack of reproduction of valuable forage plants, will leave the range in even poorer condition than at present when the existing generation of several species has passed out. Ring counts made on 35 plots in Wah Wah and Pine Valleys, Utah, showed that white sage, a valuable forage, ranges from 20 to 71 years of age with an average of 34 years. The evidence shows that no seedlings of this plant have become established during the last 20 years. In Wah Wah Valley white sage is being replaced by little rabbitbrush (Chrysothamnus spp.) an inferior forage plant. Of the existing rabbitbrush plants, 43 percent are seedlings and none exceed 37 years of age. In little rabbitbrush 21 percent were dead as compared to 88 percent of white sage. In Pine Valley gray molly (Kochia vestita) is the invading plant. Of these, 24 percent are seedlings, and none exceed 9 years of age. Only 7 percent of gray molly plants were dead as compared with 90 percent for ricegrass (Oryzopsis spp.) and 29 percent for white sage. Ring counts and invasion data obtained in Wah Wah and Pine Valleys are shown in Tables 2 and 3.

Table 2. Summary of plant invasion data taken in Wah Wah Valley

Species	Total Plants	% Mature	% Dead	% Seedlings	Average Age	Range in Age
White sage	159	12	88	0	35	20-64
Rabbitbrush (Yellowbrush)	161	41	16	43	8	0-37

Table 3. Summary of plant invasion data taken in Pine Valley.

Species	Total Plants	% Mature	% Dead	% Seedlings	Average Age	Range in age
White sage	272	71	29	0	34	23-71
Ricegrass (Oryzopsis)	21	10	90	0	-	-
Galleta grass (Hilaria jamesii)	343	82	18	0	-	-
Gray molly (Kochia vestita)	1,155	69	7	24	5	0-9

Palatability studies to date show the following:

		% Palatable
1.	Black sage (Artemisia nova)	95
2.	Ricegrass (Oryzopsis spp.)	95
3.	Bud sage (Artemisia spinescens)	90
4.	White sage (Eurotia lanata)	80
5.	Squirreltail (Sitanion hystrix)	80
6.	Mormon tea (Ephedra viridis)	65
7.	Slippery elm (Sphaeralcea coccinea)	60
8.	Mt. mahogany (Cercocarpos intricatus)	45
9.	Galleta grass (Hilaria jamesii)	35
10.	Shadscale (Atriplex confertifolia)	30
11.	Russian thistle (Salsola pestifer)	20
12.	Little rabbitbrush or yellowbrush (Chrysothamnus stenophyllus)	20
13.	Matchweed (Gutierrezia sarothrae)	15
14.	Three-awn grass (Aristida spp.)	10

15.	Gray molly (Kochia vestita)		10
16.	Needlegrass (Stipa comata)	5 = sheep	90 = cattle & horse
17.	Dropseed grass (Sprobolus spp.)		10 = sheep

Revegetation Studies

The desert ranges of Utah and Nevada have been so seriously depleted that methods of revegetation become an important problem. To study revegetation methods, seven 4-acre enclosures were built adjacent to each of these an open grazed or control plot was established and the vegetation on each area was carefully mapped in detail and plant cover estimates were made. These plots will be used as check in determining possibilities of rehabilitation of depleted ranges under complete protection. Five enclosures and five grazed plots are on the west desert in Utah while the remaining are on the east desert.

On each of the above areas, four quadrats four square meters in area were established and mapped. (It was found that smaller quadrats did not give a fair representation of the vegetation.) These areas will be remapped every five years or thereabouts and the quadrats recharted to determine the changes which occur in the vegetative cover.

Plans for 1933

The establishment of the desert experiment range makes it possible to centralize the research studies and greatly facilitate the work. Plans for 1933 provide for making a detailed range survey of the experimental and adjacent range and the development of plans for experimental management of the range, including range rehabilitation, methods of grazing management, plant development and palatability, nutritive value of desert vegetation, ecological correlations and soil relationships.

ARTIFICIAL RESEEDING

Since 1925 the work in the artificial reseeding project has been centered in the oak brush zone on the Wasatch Plateau in Utah where the main growing season extends from May 1 to August 31. Trials include yellow sweet clover, white sweet clover, crested wheatgrass (Agropyron cristatum), bromegrass (Bromus inermis), and Medicago lupulina made in cooperation with the Bureau of Plant Industry.

Progress during 1932

Work during 1932 was limited to examinations at three different intervals during the season of all previous sowings. No plantation sowings were made and only three nursery tests were established. These consisted of Waldron timothy, two in the oakbrush zone and one in the aspen-fir zone. In general the species in all tests made very good growth and matured seed. Crested wheatgrass particularly made excellent growth. This species as shown in the following table also withstands grazing very well. In each case the density of crested wheatgrass continued to increase after being subjected to grazing the previous year.

Table 1. The effect of moderate grazing on crested wheatgrass (Agropyron cristatum) and common bromegrass (Bromus inermis).
(Density estimates made prior to grazing in 1931 and again in 1932)

Species	Method	Date of Sowing	Density of Plot		Density of Species	
			1931	1932	1931	1932
Crested wheatgrass (9c)	Plowed furrow & brushed in	June 1929	.45	.55	.0675	.1375
Crested wheatgrass (9b)	Trampled by sheep	" "	.30	.40	.0090	.0440
Crested wheatgrass	" " "	" "	.30	.40	.0300	.0600
Common brome (11)	Plowed furrow & brushed in	Oct. 1929	.46	.55	.0414	.0825
Crested wheatgrass	" " " " "	" "	.45	.50	.0405	.0600
Common brome (5c)	" " " " "	June 1929	.31	.35	.0620	.0980

The examination also revealed important data as to the time of sowing as shown in the following table which compares spring sowings and fall sowings of crested wheatgrass and bromegrass at three elevational stations located in the oakbrush zone . In practically every case spring sowings gave better results than fall sowings. However, the particular season must be considered as well as methods. In other words sowings made in the spring of 1929 were subject to better growing conditions than those made in the fall of 1929, due to the excessive dry year of 1930.

Table 2.

Early vs. Late Sowings
MAJORS FLAT ARTIFICIAL RESEEDING AREA
Elevation 6,900'

Species & Source of Seed	Method	Date of Sowing	Density of Plot	Density of Species
Crested wheatgrass (Creston, Mont.) (Plot 7)	Plowed furrow and brushed in	Oct.1929	.35	.0210
Crested wheatgrass (Dickinson, N.D.) (Plot 11)	do.	do.	.50	.0300
Crested wheatgrass (Dickinson, N. D.) (Plot 30)	Plowed furrow and seed not covered	Oct.1930	.45	.0450
Crested wheatgrass (Dickinson, N.D.) (Plot 31)	Plowed furrow and brushed in	do.	.50	.0500
Crested wheatgrass (Dickinson, N.D.) (Plot 18)	do.	May 1930	.55	.0440
Common brome (Lawrence, Kans.) (Plot 9)	do.	Oct.1929	.40	.0800
Common brome (Salt Lake City,Ut) (Plot 33)	do.	Oct.1930	Very poor stand no figures	
Common brome (Salt Lake City,Ut) (Plot 20)	do.	May 1930	.35	.0525

MAPLE CR. ARTIFICIAL RESEEDING AREA
Elevation 7,890'

Species & Source of Seed	Methods	Date of Sowing	Density of plot	Density of Species
Crested wheatgrass (B.P.I. Plot 17)	Plowed furrow & brushed in	Oct.1929	.50	.0600
Crested wheatgrass (Dickinson, N.D.) (Plot 9c)	do.	June 1929	.55	.1375
Common brome (Lawrence, Kans.) (Plot 11)	do.	Oct.1929	.55	.0825
Common brome (Lawrence, Kans.) (Plot 5c)	do.	June 1929	.35	.0980

ASPEN ARTIFICIAL RESEEDING AREA
Elevation 8,100'

Species & Source of Seed	Methods	Date of Sowing	Density Of Plot	Density of Species
Crested wheatgrass (Dickinson, N.D.) (Plot 3)	Plowed furrow & brushed in	Oct.1929	.40	.0800
Crested wheatgrass (B.P.I. 601) (Plot 5)	do.	Oct.1929	.45	.0225
Crested wheatgrass (Dickinson, N.D.) (Plot 21)	do.	June 1929	.45	.1800
Common brome (Lawrence, Kans.) (Plot 1)	do.	Oct.1929	.50	.1400
Common brome (Lawrence, Kans.) (Plot 22)	do.	June 1929	.55	.2475

Plans for F.Y. 1934

No new tests will be started in 1933 but seed beds will be designated and prepared for snow sowings to be made in the early spring of 1934. Recurrent field examinations will be made of all previous sowings with a view of determining finally the tests to be continued and those to abandon in connection with a progress report. All other available time will be devoted toward compilation and analysis of the data collected since 1929.

EROSION AND STREAMFLOW

Bunchgrass -Granitic Soils

Among the chief difficulties in determining the influence of plant cover on surficial run-off and erosion for a variety of conditions of cover, slope, soil, quantity and intensity of rainfall and treatment of the cover on experimental plots under natural rainfall and run-off conditions are lack of uniformity in quantity and intensity of rainfall in individual storms, the long time required to obtain significant results and the high cost of the numerous installations required. To meet this problem a portable unit of apparatus has been developed more quickly and cheaply to isolate and measure each of the several factors, including rainfall intensity, which influence run-off and erosion on the granitic soil type. The newly developed apparatus includes parts and principles of instrumentation which have been used elsewhere in surficial run-off studies but is different chiefly in that it is completely portable. Essentially, the new apparatus consists of the following units:

1. A pump and hoseline for conducting water under pressure from any convenient source to a study area.

2. A takedown sprinkler device which is capable of producing controlled applications of artificial rainfall, from light showers to cloudbursts, over an area about 25 x 50 feet.

3. Plot equipment for delimiting a horizontal projectional area 6.6 x 33 feet (5 mil acres) on the ground and a collector trough for diverting eroded material and run-off toward measuring devices.

4. A battery of from 5 to 7 rain gauges (including two tipping bucket gauges) for measuring the amount and rate of applied artificial rainfall.

5. A silt trap for collecting eroded material which is so designed that run-off from the plot may be relieved of silt without interrupting the rate of flow toward the run-off gauge.

6. A tipping bucket gauge for measuring the amount and rate of run-off.

7. A multiple-pen instrument for recording simultaneously the amount and rate of rainfall and run-off.

8. A 3/4-ton truck and trailer for transporting the outfit.

In general, the outfit embraces several features which are of special importance in the study of surficial run-off. First, the element of portability makes possible the study of many comparable and contrasting sites in a relatively short time. Secondly, the sprinkler device makes possible the application of controlled amounts of artificial rainfall and therefore eliminates the highly variable factor of normal rainfall. Finally, aside from the element of portability, improvements have been made in the design of several of the instruments which are essential for all studies of run-off and erosion. These improvements include: (1) a new type run-off collector trough; (2) a new type silt trap; (3) a new method for collecting eroded material; and (4) an improved contact arm on the run-off tipping bucket gauge.

The major portion of the 1932 field season was devoted to testing the various parts of the outfit and the assembled unit. These tests have suggested further improvements in the design of various parts and it is planned to incorporate these improvements prior to the 1933 field season.

In testing the assembled unit a few results were obtained relative to the erodibility of a typical site on the Boise River watershed. This site was characterized by a coarse textured sandy soil of granitic origin, a 25 percent slope, and an undisturbed and pure stand

of cheatgrass (Bromus tectorum) of about two-tenths density. On this site, approximately one inch of rainfall was applied in turn to each of four plots. On the first two, rainfall was applied at the rate of .02 inch per minute and at the rate of 0.04 inch per minute on the last two plots. When the rainfall was applied at .02 inch per minute, run-off amounted to only 18 percent whereas 42 percent of the rainfall ran from the plots when the same volume was applied at .04 inch per minute. The light application of rainfall caused a removal of only 24.5 pounds of silt per acre whereas the more rapid application caused the removal of over 100 pounds of silt per acre. These meager results, while not conclusive, indicate the importance of rainfall intensity in erosion studies and suggest the type of information it is possible to secure with the aid of this unit of apparatus.

Plans for F. Y. 1934

1. To measure with the newly developed apparatus the erodibility of a wide range of site conditions on the Boise River watershed by subjecting each to three distinct intensities of artificial rainfall and to report the results in manuscript form prior to the next field season.

2. To locate areas for permanent plot installations, to be situated in the proximity of a field headquarters station.

UTAH FLOOD AND EROSION SURVEY

A cooperative project participated in by this station, the Utah State Land Board, and the Utah State Agricultural Experiment Station was started in 1931 and continued through 1932, for the purpose of studying the areas in Utah where floods and abnormal erosion have occurred in recent years. About thirty flood areas in the state were examined in the course of two field seasons and detailed records were made regarding the existing conditions of cover, slope, soil, geological structure, and other pertinent factors.

The findings of this survey have been incorporated in "Report of Utah Flood Survey 1931-32" which was submitted to the Utah State Land Board, but has not yet been published. The survey report covers for twenty-five flooded areas in the state: (1) the nature and extent of occurrence of abnormal floods and erosion, (2) the contributory causes, (3) the possible and practical means of prevention and control, (4) what further research is desirable for the eventual solution of the watershed problem in Utah.

The findings indicate a high probability that floods generally following summer or autumn rainfall of torrential character have increased materially in Utah since settlement. Exact records of the amount and intensity of rainfall for use in weighing the climatic factor are lacking for most of the mountain watersheds. The extent, abundance, and condition of plant cover on the watershed is considered to be the primary factor that has influenced the amount of surface run-off, and other physiographic features generally are of secondary importance. In fifteen cases out of

twenty-five of recent flooding, depletion of plant cover by overgrazing and to a limited extent by burning, was found to be the chief factor responsible for the excessive run-off which produced the floods. In seven cases, naturally sparse cover, coupled with overgrazing, accounted for conditions favorable to excessive run-off. In only three cases were natural physiographic features of steep topography and bare rock exposure judged to be the factors chiefly responsible for the production of floods from heavy rainfall.

Land ownership of the areas involved was determined from State, Federal and County records after the field examination was completed. It was found that in sixteen out of twenty-five cases the watershed lands were privately owned or public domain lands on which little or no consideration is being given to the degree of utilization of the plant cover in relation to watershed protection. In nine cases the watershed lands were principally national forest lands, on which consideration is being given to utilization of the plant cover in relation to watershed protection. Of the nine, all but two cases relate back to depletion of cover prior to establishment of the national forests. Considering that the proportion of watersheds on national forests is much larger than the number outside, flood areas are much more numerous on private and open public domain land. Recommendations for measures to abate floods were concerned principally with the necessity for improvement of plant cover conditions on the watersheds, through regulation and restriction of grazing use. The place of engineering structures in flood and erosion control was covered only incidentally since that phase is the subject of another report submitted by a different agence. Recommendations for the development of a watershed protection policy for the State of Utah were outlined.

Plans for 1933.

Field work in the project as planned is completed. The results will be used in solving the flood problem in Utah.

COLORADO RIVER WATERSHED EROSION SURVEY

The extensive field survey of erosion conditions in the Upper Basin of the Colorado River watershed in Wyoming, Utah and Colorado was continued in 1932 to include the drainages of the Paria, Escalante, and Fremont Rivers which had not previously been examined.

The objectives were to gain further knowledge of the extent, character, effects, and rate at which erosion was occurring with special reference to its probably acceleration since the time of settlement of the region which had been indicated in the previous work elsewhere.

Fully 90 percent of the area of the above watersheds falls within the classification of serious erosion, in which stream channels are entrenched in valley floors and sheet and gully erosion are active on a majority of the watershed. Light erosion conditions obtain only on relatively small areas where lava rock formations have formed a protective cover for the underlying more easily eroded sedimentary formations. As a whole, these drainages contribute heavily to the silt load of the Colorado River, especially during the frequently recurring floods.

Search for areas of virginal plant cover conditions was rewarded only with the discovery of small isolated areas which had not been grazed to a great extent. Comparison of conditions on these areas with those on the grazed ranges serves to illustrate the fact that profound changes in plant cover and soil conditions have occurred generally in the region, largely by reason of the influence of grazing of livestock, but none of

the "virgin" areas found were of sufficient size to show conclusively the effect of unmodified cover conditions on a stream or drainage entirely included within the area where such original conditions obtained.

Although natural conditions here such as sandy, easily erodible soil, and frequent rains of a torrential nature, are generally conducive to a rather rapid rate of normal erosion, it appears certain that the rate of erosion has been accelerated to a marked degree within the period of time since settlement of the region by white men. Study of the sediment deposits and humus horizons which are exposed in the cross sections of certain stream channels which have been cut to their present depths within definitely known periods of time, reveal the occurrence of former periods of alternate cutting and filling processes which occurred at intervals long antedating the period of settlement and historical record. In no case observed, however, do these "pre-settlement" cuttings reach the depth to which the more recent or present cutting has taken place within definitely known and relatively short periods of time. The thickness of humus horizons in exposed sections of present channel banks and their position with reference to the former channels indicates a long period of slow accumulation of material prior to the time at which the "post-settlement" channel cutting took place.

In the case of other streams, the presence of aged trees growing at different channel bank terrace levels affords an opportunity for approximately the dates of changes in the former valley floors. Also in certain streams the rate of headward erosion can be definitely fixed by the local

settlers who have personal knowledge of the time at which the cutting reached certain stages of progress with reference to local land marks.

Modification of the plant cover, chiefly through overgrazing by livestock, is believed to be the most influential causal factor of accelerated erosion on these watersheds. Overgrazing of the watersheds alone, however, does not account for all of the accelerated stream channel erosion. Much of it is the result of destruction of the former plant cover on the channel fill which formed a relatively wide flat canyon bottom adjacent to the streams. Trailing of livestock up and down the stream valleys further aided by forming channels in which run-off accumulated and began to erode, eventually in many cases to start the channel cutting. Injudicious location of old wagon roads further contributed to the start of channel cutting. Carelessness with waste irrigation water, cultivation of valley bottoms and poorly located diversion ditches have added further to the general channel cutting now prevalent wherever there has been settlement.

The occurrence of destructive floods, the loss of arable lands through flood debris deposit, stream channel widening, and gully cutting, the reduced range forage production capacity through soil depletion and removal, have been responsible for the abandonment of formerly cultivated farm lands, homes, and even whole settlements.

The observations made serve to further substantiate the phypothesis of accelerated erosion activity in the Colorado River drainage, and the influence exerted on it by the various factors introduced into the region by white men.

A full report covering the findings of the 1931-1932 field survey is in course of preparation which will when finished complete the planned survey project.

PROGRESS WITH PUBLICATIONS DURING THE YEAR

In Manuscript Form

For Departmental Publication:

Bailey, R. W., C. L. Forsling, and R. J. Becraft. - Floods and Accelerated Erosion in Northern Utah. (USDA Circular) Submitted to editor, should be published within year.

Connaughton, C. A. - Growth of Virgin Ponderosa Pine in Central Idaho. (To be published as Department Bulletin or Circular.)

Craddock, G. W., C. L. Forsling, and W. A. Denecke. - The influence of climate and methods of management on spring-fall range in relation to range sheep production in southeastern Idaho. (USDA Tech. Bul.)

Griswold, Sylvia M. - The role of seed germination in plant succession. 1932. (Journal of Agri. Research).

Pearse, C. Kenneth - A preliminary ecological study of the vegetation on a portion of the Boise River watershed in relation to livestock grazing. (J.A.R.) Manuscript to be completed and submitted to editor.

Nelson, E. W. - The influence of precipitation and grazing upon black grama grass range. (USDA Tech. Bul.) In hands of editor.

Renner, F. G. - Erosion on the Boise River watershed as affected by various biotic and physiographic factors. (USDA Tech.Bul.) Being revised by author following board of review comments, should be published during F.Y. 1934.

Stewart, Geo. - Survey of Range Sheep Management and Losses in Typical two Communities, Utah.

Ready for Publication

Pearse, C. Kenneth - An area list method of measuring plant populations. Will probably be accepted by Ecology or similar journal.

Deming, Milo H., R. W. Bailey, and R. J. Becraft. - Utah Flood Survey Report.

Prospective Manuscripts for F.Y. 1934

Connaughton, C. A. - Fire damage survey in cut-over and virgin ponderosa stands of central Idaho.

_____ and E. L. Mowat. - The effect of crown and ground cover on the accumulation and melting of snow.

Mowat, E. L. - The application of permanent sample growth data to cut-over stands.

Craddock, G. W. - Surficial run-off and erosion on granite soils in relation to intensity of rainfall, density of vegetation and the influence of trampling by livestock.

_____ - A portable unit of apparatus for measuring surficial run-off and erosion under controlled conditions of artificial rainfall.

_____, and C. Kenneth Pearse. - A study of the root systems of range plants on the granitic soils of Idaho in relation to erosion control.

Deming, Milo H. - Relation of Climatic Trends to Accelerated Erosion in Colorado River watershed.

Nelson, E. W. - The influence of climate upon the seasonal growth and development of range forage plants in three vegetative zones.

Stewart, George - Plant sap studies on native vegetation, Utah.

_____ - Soils studies from Boise and Sawtooth Forests, Idaho.

_____ - Technique of improved method range survey.

Projects ready for compilation, analysis and report:

Stewart, George - Survey of forage condition on spring-fall and winter ranges, Utah, Idaho, Nevada.

Forsling, C. L. and G. W. Craddock. - A study of the influence of different degrees, frequencies and season of grazing and harvesting on the yield of range forage. Technical report on result of eight years of study.

Nelson, E. W. - The effect of year to year variations in climate on the growth and development of important range plants in three climatic zones on the Wasatch Plateau of Utah.

Accepted for Publication (Articles)

Stewart, George - Land Onwership in Utah. Bul. State Dept. Education, (Utah.)

Published Since Last Report

Connaughton, C. A. - The effect of forest cover on snow melt. (Forest Worker.)

Hutchings, S. S. - Light in relation to the seed germination of Mimulus ringens L. American Journal of Botany, vol. XIX, no. 7, 1932.

Forsling, C. L. - The water conservation problem in forestry, Jour. of Forestry, vol. XXXI, no. 2, 1933.

ADMINISTRATIVE SECTION

ADMINISTRATIVE GRAZING INVESTIGATIONS

The Region has about twenty administrative range investigative projects in progress. Comments will be made on only a few outstanding points in this report.

During the past year 116 fenced and 92 unfenced range observation plots were established by the rangers, making a total to date of 819 fenced and 974 unfenced. This includes plant development stations. Forty-eight fenced and 56 unfenced quadrats and species plots were established, making a total of 484 fenced and 1097 unfenced to date. Numbers of identified plant species increased 540 in rangers' herbaria and 304 in Supervisors' herbaria during the year, making a total of 7,105 in rangers' and 11,289 in supervisors' herbaria.

Plant Development Records

The compilation of plant development records kept during past years by the rangers throughout the Region was completed last fall and analysis is being made of the records in the Washington office this winter. The compilation consisted of about fifty thousand separate growth records of various individual species.

Karroo Bush Introduction

Attempts to introduce species of Karroo bush during the past season have not been successful to date as but few of the seeds have germinated. There is a possibility the seeds will yet germinate after a resting period and with more favorable moisture conditions. A few plants were growing vigorously last fall. Another lot of seeds has been received from South Africa and efforts to introduce the plants will be continued this spring.

Tall Larkspur Eradication

From the studies thus far, several general conclusions have been reached:

1. We have not "eradicated" the larkspur, but have only "controlled" it.

2. Grubbing is better than spading.

3. Moderate use of "atlacide" does not kill a high enough percentage of the plants and if large amounts were used, or several light applications made, the cost would be prohibitive.

4. There is a great difference in the effectiveness of good and bad grubbing. The comeback of the plants the following year has ranged from 15 percent with the best grubbing to 80 percent with the poorest, not counting one project where numerous seedlings ran the number the second year far beyond the number when the grubbing was started.

5. The principal causes of poor grubbing are:

   a. Grubbing too early when plants are small.
   b. Leaving plants.
   c. Not getting deep enough.
   d. Letting pieces of crown drop back in the hole.
   e. Not getting out wide enough to get all the crown.

   The latter is probably the biggest factor.

6. Larkspur control should be initiated only when change from cattle to sheep or some other practical change in management can not be made and the saving in cattle for the year grubbing is done and possibly for a year or so after, will well offset the cost of control.

It must be borne in mind that the above studies are not conclusive. There is need for much more thought and study on the larkspur eradication question.

Artificial Reseeding

A few artificial reseeding projects are being conducted by rangers at present. Plans are now being made to begin a reseeding trial on a fairly large scale this spring.

Kaibab Biological and Game Management Study

During the year additional equipment was obtained and fenced plots of various kinds established so the ground work has now been laid for a well rounded out study which is well under way.

Following are brief statements of data obtained during the past season:

Growing conditions were very favorable, except that the ponderosa pine and lower zones were dry in late summer and fall. Forage production was generally much greater in 1932 than in 1931.

The average utilization of cliff rose (which is the key species) during the winter period was 68 percent.

Weights show that leaves represent 65 per cent and current year's twig growth 35 percent of the volume of forage produced by aspen reproduction, which figures are used in arriving at average utilization.

It was estimated aspen shoots made 25 percent regrowth after being browsed in early summer.

The average utilization of aspen (which is the key species) on the summer range was 75 percent. About 60 percent of the shoot growth was taken. Only the past season or two has an appreciable amount of aspen reproduction been left on the Kaibab in the fall.

There was very little grazing of aspen before July 10.

Fallen aspen leaves and mushrooms contributed greatly to the deer diet during August and September.

It seems that deer grazed enclosures designed to admit deer but exclude stock an average of 18 percent less than the outside range.

There were from 152 to 572 aspen shoots on clear-cut plots as compared to 1 to 4 on uncut plots and the shoots were from 1.3 to 1.8 feet long on the clear-cut plots as compared to .3 to .4 feet on the uncut plots.

Snowberry was utilized 45 percent, rose 33 percent, Ceanothus fendleri 40 percent, clover 65 percent, and, as stated before, aspen 75 percent, on the summer range. It is believed this degree of utilization is about proper.

Deer seemed to remain better distributed through the summer than cattle and sheep and apparently to cause less damage to the range under the same degree of average utilization.

Very little competition exists between deer and cattle on the summer range. Direct competition exists between deer and cattle on the winter range when snow covers the grass as cliff rose is then the choice forage available for both. Deer and sheep are in direct competition on the summer range for the key species and all plants having any considerable palatability for deer. Sheep are not so selective in feeding as deer and eat much more grass and more of the less palatable forage.

Three stomach samples of deer on the summer range averaged 76 percent aspen, 1 percent snowberry, 21 percent weeds, and 2 percent grass. Two stomach samples taken in the spring on the winter range averaged 82 per cent weeds (Mostly annuals, which were abundant last spring), 17 percent browse, and 1 percent grass. Two stomach samples taken in the fall on the winter range averaged 56 percent browse (mainly cliff rose, Atriplex and sage), 44 percent weeds, and only a trace of grass.

There was a small amount of browsing on ponderosa pine as early as June 5 but the main period of browsing began about June 15 and ended about July 15 this year. No browsing was found until the terminal shoots had started to grow vigorously and were from 1 to 4 inches long. The shoots seem most palatable while growing rapidly and are succulent and tender.

There was quite heavy browsing of ponderosa pine in the areas of heavy deer concentration in the open parks and on the open hillsides.

In the heavy stands of timber, or even in the open sites away from the areas of heavy concentration, there was very light browsing of ponderosa pine. Spruce and fir were browsed lightly.

In general, the browsing of timber reproduction has been much lighter the past two or three years than for some time previously. Some browsing of coniferous reproduction must be permitted under present forage conditions if the range is to be fully utilized by deer.

Evidence from studies to date indicates that the choice forage in DeMotte Park (VT Ranch) is the principal factor in drawing the deer to that locality.

ADMINISTRATIVE GAME STUDIES

The Region's game studies during the year have centered largely around elk and deer. The studies were both technical and administrative.

Technical Studies

The Beaver District, Fishlake National Forest, is stocked with 2,150 cattle, 8,300 sheep, and by what is estimated to be 8,000 deer. The summer range generally is badly overgrazed. The deer winter range has its areas of concentration and abuse, but is not nearly the problem that the summer range is. To isolate the degree of use by game from that of livestock, three series of plots have been established: The first series is on the high cattle range; the second on the intermediate sheep range; and the third on the early spring range. Each series consists of a set of three plots: One is open to grazing by both deer and livestock; one is enclosed to exclude livestock but permits deer to enter; the other, a check plot, is also fenced and excludes all grazing animals. All vegetation within the plots has been carefully mapped or measured. Several utilization plots have also been established. It is expected that these studies, together with other studies and observations being made on the district, will indicate at least the extent of use by game separated from that of livestock. It is contemplated to initiate similar studies on the Dixie this spring.

Administrative Studies

Economic Value

Checking stations were established on the Beaver District to collect data concerning the number of hunters, deer removal, and economic value:

2,090 hunters checked in.
1,337 bucks taken.
52 does and fawns illegally killed and reported.
$16.33 average expenditure by each resident hunter.
$67.50 average expenditure by each non-resident hunter.
$17.00 weighted average.

On forms prepared for compiling hunting cost data, 448 resident hunters reported the following expenditures:

Gasoline	$911.40
Oil	187.65
Car repairs	223.82
Storage	10.55
Hotel, lodging	191.20
" meals	310.45
Clothing	556.23
New guns and repairs	738.50
Ammunition	742.07
Camp supplies	185.40
Other expenses	1511.21
Horse hire	209.00
Man hire	644.00
Licenses	896.48
Total	$7317.48

They used 175 automobiles, traveled 69,362 car miles, killed 297 bucks, or 66 percent got deer, spent 5.4 days each on the hunt, including time going and coming. The economic value of this one deer herd is considerable when it is realized that the 2,090 hunters spent over $35,000.000 in pursuit of the elusive buck.

Several of the forests have collected data on the cost of hunting, the cost ranging from $11.02 per resident hunter on the Challis to $38.00 on the Nevada.

Rate of Increase

The Beaver deer herd has been counted three years in succession for the purpose of getting better data on numbers and rate of increase.

The check indicates 8,000 deer. Fawn counts showed they made up 35 percent of the herd in 1931, 33 percent in 1932, and 38 percent in 1933.

Game Preserves

Studies conducted on the Middle Fork of the Salmon River Game Preserve, including forage utilization and drift of deer, showed the game preserve to be in the wrong place and resulted in its elimination by the Idaho State Legislature.

Elk Count by Airplane

In 1932 we counted the Manti and Jackson Hole elk herds from the air. While airplane counts are not 100 percent accurate, yet it is believed that under favorable conditions a more accurate count can be made from the air than by any other method. Rough, broken country with narrow, deep canyons into which a pilot cannot pull his ship with reasonable safety, cannot be flown and counted successfully and neither can large stands of dense timber. In fact, we do not know of any method of counting wild game on such areas that would give anything more than an estimate. When conditions are favorable there is no reason why a very good count cannot be made by airplane. February, when the elk have a tendency to occupy the open ridges, sidehills and sparse timber stands, has proven the best method. Clear, cold weather is desirable and snow is essential. One or two days following a storm makes it easy to pick up the tracks and by circling the elk can be readily located and counted. Flying about 600 to 800 feet above the ground gives excellent visibility. A monoplane, cabin type, low cruising speed and lightly loaded has proven the most practical.

SUMMARY OF

FOREST MANAGEMENT

PROJECTS

RS - INT
Mc - Ponderosa Pine

April 1, 1933

Project: Methods of cutting and natural reproduction of ponderosa pine.

Scope: To determine the most satisfactory cutting policy from economic, silvicultural, reestablishment, and watershed standpoints of ponderosa pine as a reliable basis for management within the entire type in the region and more especially on granitic soils. To secure this result, information must be obtained on cutting methods, total and net growth by trees and crown class, logging damage and brush disposal, the response of advance reproduction, and the germination, survival, and growth of subsequent reproduction.

Status: Old project revived in F. Y. 1931. Four cut-over, and 16 virgin stand 5-acre plots were taken over by Station and remeasured in 1931. All data were coded and transferred to punch cards for machine compilation.

Results: A. Compilation of data for 16 plots in virgin stands was nearly completed and progress report in preparation. Summary shows gross annual growth per acre of 281 bd. ft. or 50.9 cu. ft.; net annual growth of 140 bd. ft. or 25.3 cu. ft. for all plots over 17-year period. Simple method of predicting growth in unevenaged stands is being devised.

B. An inventory was made of four Forest Service timber sale areas and one private cut-over tract to secure data for application of growth data for permanent plots. Cruise covered 3,000 acres, chiefly by 5 percent line-plot system.

C. Two permanent 5-acre plots were established near Idaho City to study heavy partial cutting by private operator. Cutting removed 19,150 bd. ft., leaving 4,700 bd. ft. per acre.

Plans: Analysis of plot data, virgin and cut-over will be completed and reports prepared. Cut-over study data will be compiled and correlated with plot growth figures. The following lines of work will be undertaken on the experimental forest: (1) establishment of several permanent plots, totaling about 40 acres, to study distinct methods of cutting, as outlined in working plan and in past annual reports; (2) intensive 100 percent cruise of portion of Pine Creek drainage; (3) establishment and remeasurement of extensive permanent reproduction transects; (4) slash disposal studies; and (5) development work on headquarters site.

Assignment: C. A. Connaughton and E. L. Mowat.

RS - INT
Mc - Ponderosa Pine
(Plant Succession and Reproduction)

April 1, 1933

Subproject: Natural reproduction as affected by associated vegetation and related factors in the central Idaho ponderosa pine type (revised title).

Scope: To determine the effect of density, composition, and height of the lesser vegetation upon establishment and height growth of ponderosa pine reproduction both before and after logging, including the influence of such factors as shade and soil moisture competition.

Status: The first year's work attacked chiefly the question of effects of the shade and root competition on reproduction and lesser vegetation by an intensive study of quadrats around living and dead trees in a virgin forest on cut-over areas of three ages and a comparable virgin stand. Survival of pine seedlings was found to be definitely better on the shadier sides of trees, indicating that competition for soil moisture rather than light is the important factor. Subsequent reproduction was in general very meager in quantity on southerly slopes of the six national forest and private cut-over areas examined. Only 112 subsequent seedlings were found on about 20 acres cut-over in 1925, and 83 percent of these had germinated within two years after logging. The favorite place for these seedlings was beside stumps. Other situations which were comparatively well stocked were around the edges of slash pile burns and beside logs, sticks, and skid trails. They were least abundant where the lesser vegetation had not been disturbed in any way and litter was thin or absent.

Plans: If cooperation is available, field work along similar lines will be continued during the 1933 season. More data should be secured to show factors affecting advance reproduction, which it is apparent must largely be depended upon for restocking under present cutting practices. The additional effects of grazing and burning have barely been touched upon; it is doubtful whether mor than a suggestion of these effects can be derived from the study without enlarging its scope more than is desirable. A final report should be prepared by May 1, 1934.

Cooperation: University of Idaho.

Assignment: Floyd Otter, (Collaborator (Instructor, School of Forestry, University of Idaho.)

RS - INT
MC
(Snow Storage and Recession)

April 1, 1933

Subproject: The effect of varying quality and character of forest cover as may result from different methods of cutting on the depth and water content of the total accumulated winter snow and its rate of melting.

Scope: To determine the effect of the character and degree of ground and crown cover in ponderosa pine stands of central Idaho, on the amount, water content and rate of melting of the total accumulated winter snowfall.

Status: The project was initiated in the spring of 1930 as a result of serious objections raised by irrigators to the prevailing methods of cutting ponderosa pine with regard to its effect on streamflow. The following ground and crown covers are represented: a typical overmature, clean-floored ponderosa pine stand, an overmature ponderosa pine stand with a dense understory of 30-year-old reproduction, a stand of 30-year-old reproduction, a dense stand of sagebrush, and bare ground.

Results: The results in 1932, a year of heavy snowfall, confirm the conclusions from the 1931 results, namely, that a maximum amount of snow storage is favored by a minimum forest cover and that the rate of snow melting is retarded by forest cover. Considering the accumulated snow cover of 17.52 inches water content on the bare ground as 100 per cent, snow storage under the other conditions was as follows: Sagebrush 103.08 percent; young growth 95.72 percent; mature-timber-without-undercover 81.39 percent; and mature-timber-with-advance-reproduction 77.63 percent. The bare ground plots became bare first, 30 days after maximum snow accumulation, and the mature-timber-with-advance-reproduction became bare 7 days later. A progress report was prepared for publication.

Plans: Regular measurements and mapping of the spring snow recession will be continued through 1933 when the project will be completed.

Assignment: C. A. Connaughton and E. L. Mowat.

RS - INT
Pf - Damage

April 1, 1933

Subproject: Fire damage in ponderosa pine forests of central Idaho.

Scope: To determine losses in timber, forage, and watershed values caused by fire in the ponderosa pine type as a basis for more accurate and comprehensive appraisals of fire damage, including both those losses which are immediately apparent and those which are indirect or delayed.

Status: New project, field work started May 1, 1932.

Results: The field work in 1932 was concentrated in and around the fire known as the Boise Basin burn, which occurred in 1931, burning approximately 45,000 acres mainly in the ponderosa pine type representing virgin timber stands, private cut-over land, and large second growth areas. Five thousand one hundred twenty acres of virgin national forest timber land and 5,330 acres of private cut-over land were cruised on a 10 percent basis by the line-plot system. Detailed information on timber stand and other forest conditions, character of fire, nature and degree of injury, etc. was recorded in code form on 4,176 quarter-acre plots. Ten permanent sample plots, totalling 21 acres, and 126 chains of vegetation and reproduction transects were established. The coded cruise data have been punch-carded and await machine sorting and compilation.

Plans: An initial report will be prepared in 1933 following compilation and analysis of the cruise data. Permanent plots and transects will be examined annually and remeasured probably every five years to determine further losses and changes. Date of completion of permanent plot phase indefinite.

Assignment: C. A. Connaughton and E. L. Mowat.

RS - INT
ME - Ponderosa Pine
Growth, Evenaged Stands

April 1, 1933

Project: Yield of evenaged stands of ponderosa pine.

Scope: To construct normal yield tables for ponderosa pine which will be applicable insofar as possible to the entire range of the species. Includes Regions 1, 2, 3, 4, 5, and 6, each providing field measurements of temporary sample plots in fully stocked, evenaged, practically pure stands.

Status: New project for Intermountain region. Initiated in 1928 by Pacific Northwest Forest Experiment Station; expanded to interregional study in 1932. Prospective stands in Region 4 were examined in September, 1932.

Plans: If possible a minimum of 50 temporary plots will be measured in 1933, sampling all ages and sites which can be found. Most of the field work will be done in central Idaho, with a few plots in southern Utah and northern Arizona.

Assignment: ~~Gxxxxxxxxxxxxxxxxxxxxxx~~ E. L. Mowat, under general direction of W. H. Meyer of the Pacific Northwest Forest Experiment Station, which will handle compilation of all data.

SUMMARY OF

RANGE MANAGEMENT

PROJECTS

RR - INT
Management
Summer Range (Wasatch Plateau)

April 1, 1933

Project: The development of methods of range management on high mountain summer range lands to insure the maintenance and improvement of the grazing capacity of the native forage crop in the manner best to meet the requirements of the range itself, of the dependent livestock, and of the related forest land resources.

Mountain and Scope: This broad project logically breaks down into a number of subprojects or phases, of which the following are under study at the present time.

1. The effect of climate on plant growth.

2. Natural revegetation as a means of improvement and maintenance of the range.

3. The degree of utilization as a factor in range management.

4. The influence of season, frequency and degree of harvesting on the productivity, revegetation and vigor of range vegetation.

RR - INT
Management
Summer Range (Wasatch Plateau)
(Climate and Plant Growth)

April 1, 1933

Subproject: The effect of climate on plant growth.

Character and

Scope: To determine for mountain summer range (1) which of the more common climatic factors are of primary importance to forage growth, and (2) the part climate, and particularly the fluctuations in climate from year to year, play in (a) forage development and production, (b) the outcome of experimental work generally, and (3) the adjustments in range management necessary to meet fluctuations in forage production.

Progress

Status: Records of the more important climatic factors have been kept during the main growing season continuously since 1914, and in some instances yearlong, in three vegetative (altitudinal) zones on the Wasatch Plateau in Utah. Forage yield and time and rate of growth have been observed since 1924 to correlate plant growth and forage yield with the climatic factors.

Results: Vicissitudes of climate as they affect both the time and length of grazing season and the quantity of forage produced have long been recognized to play an important role in range management and forage production. Nevertheless, other exigencies have lead to practices of making both range management and livestock handling conform more or less to set calendars of operation. Results to date in this study by measuring the extent of these fluctuations and their influence on time, rate and quantity of forage production show that variations in climate are so wide as to appear to justify certain elasticity in range management plans or some other provisions to meet them. Total forage production for a season, for example, may vary from as much as 40 percent above the average in one year to 40 percent below the average in another year. Also the time when grazing should begin may vary as much as 30 days earlier in one year as compared to other years.

Plans: The project will be continued along the line of developing facts and information upon which to base range use that will more adequately meet this problem of climatic vicissitudes from the standpoint of the needs both of management of the range and the needs of livestock. Any study involving climate necessarily must be on a long time basis because of the naturally wide variety of conditions to be met. Climatic records also perforce must be continued in order to be able to weigh the influence of climate in the outcome of other experimental studies.

Assignment: C. L. Forsling, R. Price ~~and E. W. Nelson.~~

Date of Completion: Indefinite

RR - INT
Management
Summer Range (Wasatch Plateau)

~~April 1, 1933~~

Subproject: Vegetational readiness and the length of the grazing season on summer range.

Clarify and **Scope:** To determine the effect of continued early use on the vigor and production of range forage plants, (2) the time at which livestock may be admitted to the range without injury to the forage from too early use, (3) methods of determining the time of range readiness, (4) the effect of close cropping of the vegetation in the fall after seed maturity, and (5) the time that grazing should be discontinued in the fall.

Progress **~~Status~~:** The results obtained prior to 1923 were published in Department Bulletin 1405.

A systematic study has been made from 1925 to 1932 of the important range plants at varying elevations to determine the variation in vegetational development (phenology) from year to year. Detailed growth records of individual plants of important forage species have been obtained from the start of growth in the early spring and continuing throughout the season until covered with snow in the fall.

~~Results~~: Plant development and growth records were obtained throughout the season for a few key stations only. Progress was made in the final compilation and analysis of field data during the F.Y. 1934

Plans: Field work has been discontinued in this project. Observations will be maintained as a part of the climate and plant growth project. Analysis of data and preparation of a report will be ~~completed~~ pushed during the F. Y. 1934.

Assignment: ~~E. W. Nelson.~~

Date of Completion: 1935

RR - INT
Management
Summer Range (Wasatch Plateau)
(Natural Revegetation)

April 1, 1933

Subproject: Range improvement and maintenance by natural revegetation of native forage species on summer range lands.

Scope: To determine (1) the most expedient and economical method of natural revegetation of native forage plants, (2) the rate of re-establishment of valuable forage plants on depleted range lands, (3) the role of seed production and germination as a factor in the natural revegetation of range lands, and (4) methods of management of livestock on the range to meet the requirements of the native forage plants for natural revegetation and at the same time meet the feed requirements of the livestock to the fullest degree possible.

Status: Seventy six quadrats, 71 major plots, and 7 intensively mapped areas have been established since 1914 in the three major vegetational zones on the Wasatch Plateau in central Utah. These plots have been remapped and rechecked at definite intervals to determine the change of the native forage cover on range lands varying in degrees of depletion, erosion and intensity of grazing. Results to 1922 have been published in Department of Agriculture Bulletins 791 and 1405.

Seeding habits, seed production, seed dissemination and germination under various conditions of storage, temperature, and moisture relationships for 55 important range species have been determined for four seasons.

Three 40' x 40' rodent proofed enclosures with accompanying quadrats and major plots were established in 1931 to obtain information on the role of rodents in natural revegetation.

Results: Approximately two-thirds of the total number of quadrats and major plots were recharted and reestimated and two intensively mapped areas were remapped. Two enlarged enclosures, one 5 acres and one 3 acres in area, were mapped, typed and estimated. Four quadrats, two major plots and two intensively mapped areas were established and recorded.

Plans: The remaining plots not mapped in 1932 will be mapped in accordance with the regular schedule. These plots will be continued for an indefinite period. Compilation will be undertaken with a view of preparing an additional progress report. The report on the study of seed production and seed germination is nearing completion.

Assignment: R. Price.

RR - INT
Management
Summer Range (Wasatch Plateau)
(Degree of Utilization)

~~April 1, 1933~~

Subproject: The proper degree of utilization of important range plants.

Clarification and

Scope: To determine (1) proper degree of utilization, (2) standards for judging utilization, and (3) percentage of good forage which should remain at time of seed maturity each year on ranges where deferred and rotation grazing is not applied to improve or maintain the forage stand.

Progress

Status: A pasture was constructed on the high summer range lands of the Wasatch Plateau in 1923 and has been grazed by a small herd of cattle since 1925. Twelve hurdle plots 16' x 16', supplemented by 12 quadrats were placed in this pasture to secure varying degrees of utilization of the important range plants each year. Field work was discontinued in 1932 and this project is ready for final analysis. All data have been compiled and are awaiting analysis

Plans: ~~Compilation~~ Completion will be pushed with the view of making a final report of the project. The pasture will be held in reserve for future studies, particularly studies to show carbohydrate relationships.

Assignment: R. Price.

Date, completion: 1934

RR - INT
Management
Summer Range (Wasatch Plateau)
(Season, Frequency and Degree of Harvesting)

April 1, 1933

Subproject: The relation of season, frequency and degree of harvesting to the productivity, revegetation and vigor of the vegetation.

Scope: To determine the effect on vigor, revegetation and productivity and carbohydrate accumulation of harvesting at different seasons, intervals, and closeness of cropping on important forage species growing on mountain summer range and to work out methods of grazing based on the results to improve and maintain the range, and at the same time obtain the best use of the forage.

Status: The main results of early work, involving 11 species and 20 methods of harvesting, are reported on in Department Bulletin 1405. The project was revised in 1923 to study more critically some of the methods previously tried out, on a plot rather than individual plant basis, supplemented with actual grazing trials. The clipping and grazing field work, except for the browse species, is completed and is being analyzed. Two important browse species were added to the clipping study in 1926 and were supplemented with hurdle plots.

Preliminary field work on the carbohydrate study was initiated in 1931 at which time plots were established and made ready for actual work during 1932. One year's work of the proposed 4-year project is now completed.

Results: The analysis of the empirical clipping methods has not progressed far enough to draw any final conclusions. The quadrats, major plots and transect plots in the grazing trials of the study were remapped and reestimated to determine the rate of recovery.

The carbohydrate study to date indicates a declining quantity of food storage at the end of the season as foliage removal approaches the stage of seed maturity. However, grazing when deferred until seed maturity showed small adverse effect on plant food storage, evidently due to the gradual removal of foliage over a period after seed maturity as compared to complete removal on a single date as in the case of the clipped specimens.

Plans: To continue the analysis of all available data in the empirical phase and to continue the carbohydrate study.

Assignment: R. Price. (Carbohydrate study in cooperation with Dr. E. C. McCarty of Riverside College.).

RR - INT
Management
Bunchgrass - Granitic Soil

April 1, 1933

__Project:__ The management of the bunchgrass-granitic soil type.

__Scope:__ To determine the best methods of range management of the bunchgrass-granitic soil type on watershed lands.

__Status:__ Eleven areas, 0.1 to 200 acres in area, have been selected and fenced to exclude livestock; 100 5x5 meter major plots and 95 meter quadrats were established under different conditions of grazed and ungrazed range. From data obtained on these plots a preliminary description of the vegetation in relation to grazing and erosion has been prepared.

Insert 1

__Results:__ Preliminary analysis of data from 24 quadrats and 35 major plots which were recharted for correlation of plant growth with climate show that the original bunchgrass cover fluctuates less with variation in climate and maintains a better protective cover than the annuals and other species which invade overgrazed areas.

Insert 2

From a study of root systems of 12 important herbaceous species, it appears that the three grasses studied are of considerable value in soil protection while the perennial weeds are generally of less value, and the annual weeds are almost worthless. A possible use of root systems to indicate the extent of past erosion by the apparent down slope movement of the root crown is one of the unexpected results of this root study.

__Plans:__ Various plots now established will be remeasured during the coming season and the data will then be ready for preliminary analysis to determine the rate of reclamation of gullies and control of erosion by natural revegetation. Root studies will be carried on on the same and additional species on varying sites of the watershed.

To increase our knowledge of climate, especially concerning summer rainfall, 20 to 25 cooperative precipitation stations will be established during the coming season.

__Assignment:__ ~~G. W. Craddock, Jr., and~~ Kenneth Pearse.

RR - INT
Management
Sagebrush-Wheatgrass

April 1, 1933

PROJECT: The management of sagebrush-wheatgrass range.

SCOPE: To determine methods of range management to improve and maintain the native forage crop on sagebrush-wheatgrass range and develop its best use for range sheep and cattle production in the Intermountain region.

The sagebrush-wheatgrass ranges of the region are thus far recognized to fall into three major subdivisions: sagebrush-wheatgrass foothills of Utah; the sagebrush-bunchgrass-giant ryegrass areas of northeastern Nevada and the Snake River and adjacent foothills in Idaho. All of these subdivisions are in heavy demand for spring and fall grazing and for the most part are now far below potential productivity as the consequence of injudicious use in the past. They have become the "neck-of-the-bottle" in range livestock production, requiring improved methods of management for economical operations.

Subproject

The management of sagebrush-wheatgrass range (Upper Snake River plains, at U. S. Sheep Experiment Station).

Status: In consideration of the importance of the range factor in sheep production, range management studies were undertaken in 1923 in cooperation with the Bureau of Animal Industry at the U. S. Sheep Experiment Station on the Upper Snake River plains in Idaho. To date the study has included the influence of yearly climate on forage growth and production and on sheep production; the influence of four systems of spring grazing, yearly deferred grazing, continuous spring, summer and fall grazing on range productivity; and carrying capacity on herded range.

Results: The systems of use and other studies to determine the influence of season of use and climatic conditions on range and livestock management were carried through their ninth year. The original draft of a manuscript for publication on this plan is nearing completion. All quadrats were remapped, all transects were reestimated and basic work was completed in 4 new paddocks preparatory to instigating an experimental grazing system to study methods of improving the range.

Plans for 1933: To complete the manuscript for publication, and to modify the experimental systems of grazing in 10 paddocks to determine methods of improving depleted range, a detailed plan of which has been sent to the Branch of Research in Washington, D. C. for approval.

Cooperation: U. S. Sheep Experiment Station of the Bureau of Animal Industry.

Subproject

The natural revegetation of sagebrush-wheatgrass range as the result of past use and burning of range.

Status: The sagebrush-bunchgrass range of the Intermountain region has suffered material changes in the amount and character of vegetation as the result of past grazing use and fire. To determine the extent of these changes, their influence upon the grazing capacity of the range, what is the potential productivity and what are the stages of plant succession and how much time is required for natural rehabilitation of this type of range is an essential basic step in developing suitable methods of range management.

A study to develop improved methods of management of these ranges, exclusive of the Upper Snake River plains, was started in F.Y. 1930. A study of the effects of vegetation of past use and fire was carried through 1930 and was published in 1932. In 1931 eight typical areas were selected and fenced for future reference as natural areas.

Results, 1932: Detailed basic data was taken in eight enclosures, established in 1931, regarding the density and composition of the vegetation. These data have been compiled and will serve as a basis of future checks on the improvement of sagebrush-wheatgrass ranges.

An extensive survey of the present condition of sagebrush-wheatgrass range in Utah and in southern Idaho was completed and was included in a report made to the Forester on Public Domain condition.

A detailed inventory of the vegetation was made on four sections of sagebrush-wheatgrass range on state lands north of St. Anthony, Idaho in cooperation with the Fremont Woolgrowers Association preparatory to determining the induced succession of bunchgrasses following furning the sagebrush.

Plans for 1933: To bagin observation on the effect of burning sagebrush on the herbaceous vegetation, if areas in Fremont County are burned in 1933.

ASSIGNMENT: George Stewart, G. D. Pickford,(G. W. Craddock pending completion of manuscript), and J. M. Cooper of the U.S.S.E.S., Bureau of Animal Industry.

RR - INT
Management
Desert-Shrub Range

April 1, 1933

Project: The management of desert-shrub ranges.

Scope: To determine, experimentally, the methods of management which will restore and maintain the grazing productivity and promote its best use, of desert-shrub ranges. This involves the character, distribution, forage value, growth requirements, and reaction to grazing of the native vegetation.

Results: An extensive sample plot survey showed that there has been a 58 percent decline in the grazing capacity of desert ranges in western Utah and central Nevada, many of the better forage species have failed to establish seedlings during the last 20 years and existing stands of more palatable species are being replaced by inferior forage plants. Sheep losses are excessive, especially during drought when they may exceed 20 percent and lamb crops also fall far below normal.

Plans: Detailed range surveys of the experimental range and adjacent areas will be made and plans for the experimental management of the experimental range to study rehabilitation, methods of grazing management, plant development and palatability, nutritive value of desert vegetation, ecological correlations and soil relationships will be developed.

Assignment: George Stewart and S. S. Hutchings.

RR - INT
Artificial Reseeding

April 1, 1933

Project: Artificial reseeding of depleted mountain summer range lands.

Character and

Scope: To determine (1) suitable species, (2) site conditions, (3) methods and time of seeding, (4) seed production, (5) methods of grazing during periods of establishment, and (6) economics of improving depleted range by introduction of tame (cultivated) and native forage species on mountain ranges in central Utah where the annual precipitation is from 18 to 30 inches, and the growing season 100 to 120 days in length.

Results

Status: Artificial reseeding trials have been undertaken since 1910 on the Wasatch Plateau in Utah. These trials have been on a small scale and of an empirical nature. A large number of forage species have been tried out at different elevations under various soil conditions, moisture, time of seeding and treatment. The results of the work up to 1927 were published in 1931 in Department Circular 178.

Practically all of the artificial reseeding tests made since 1925 have been in the oak brush zone where the main growing season extends from May 1 to August 31. The sweet clovers, crested wheatgrass, common brome, slender wheatgrass and many-flowered brome were used in most of the tests. These tests involved various methods of tilling the land, covering the seed, and time of sowing.

Results: ~~Three nursery tests of Waldron timothy were started during 1932.~~ Examinations of all former plantation and nursery tests show that practically all of the species sowed in the preceding year made very good growth and matured seed, particularly crested wheatgrass which made very excellent growth. However, rodents took practically all available seed produced. Seedlings were noted to be fairly numerous and in good vigor. Crested wheatgrass when moderately grazed continued to increase in density. and shows exceptional prospects for range reseeding both in the Oak and sage brush range lands

Plans: Examinations of results from former sowings will be continued ~~and preparations for "snow sowings" will be made for early spring work in 1934.~~

Cooperation: Bureau of Plant Industry on tests with sweet clovers, crested wheatgrass and common brome.

Assignment: R. Price (and L. W. Kephart of Bureau of Plant Industry.)

Probable date of completion: indefinite

SUMMARY OF

EROSION-STREAMFLOW

PROJECTS

R - INT
Special
Erosion & Streamflow
Bunchgrass-Granitic Soils

April 1, 1933

Project: The influence of plant cover and its use in the bunchgrass type on granitic soils on erosion and streamflow.

Scope: To determine, for watersheds of the bunchgrass type on loose granitic soils (1) the causes of erosion; (2) the rate of erosion; (3) the influence of herbaceous cover as affected by grazing use in controlling erosion and regulating run-off; and (4) methods of checking and controlling erosion and maintaining desirable run-off conditions by natural and artificial revegetation and other means. The problem involves the investigation of all the factors, especially those in which plant cover plays a part, that affect the yield and rate of discharge of water from a watershed and the erosion of the soil as a means of determining the amount, kind and regulation of cover that will obtain desirable streamflow and control erosion.

Status: 1. A range-erosion survey was made over 371,000 acres of typical watershed lands, to isolate the various factors which contribute to erosion. A report is in preliminary manuscript form.

2. A series of profile plots have been established and resurveyed to measure the rate of gully and sheet erosion.

3. A number of studies have been initiated to investigate the static factors of site and soil-plant relationships, as a step toward determining the influence of herbaceous cover on run-off and erosion. Analysis of nearly 200 soil samples show that past erosion has materially reduced the moisture capacity, organic content, nitrogen content, and clays and silts of typical soils. A special study of root systems was initiated in 1932 to determine the soil binding value of different plant species. General observations are under way to compare the degree of erosion from melting snow and from summer rains.

4. No specific studies have been started thus far to determine methods of checking and controlling erosion.

Results: The 1932 field season was devoted largely to the development of a portable unit of apparatus for measuring surficial run-off and erosion on temporary plots under controlled conditions of artificial rainfall. When finally assembled, the unit operated satisfactorily in test runs but snow and the close of the field season prevented accumulation of run-off from comparative sites. A progress report has been prepared for the files covering the development and tests of the outfit.

Continue with pg 78 a and then 79

Recheck surveys indicated that, in three years, the only appreciable changes of several gully sections have occurred through the breaking down of steep banks. Changes on the sheet erosion plots were insignificant.

Root studies show that the weeds which survive destruction of the bunchgrasses on overgrazed range have deep penetrating roots of inferior value for binding the soil. The invading annual grasses have roots of moderate to good value for holding the soil.

Insert 2 from page 73 — two sets

Plans: To measure with the portable apparatus, surficial run-off and erosion as caused by applications of ~~three~~ two different intensities of artificial rainfall on duplicate temporary plots representing different conditions of slope, cover and soil, ~~and to locate suitable areas for permanent run-off plot installations for more detailed studies of the influence of cover on run-off and erosion.~~ To complete the root study and to continue study of plant succession and rate of succession controlled by natural revegetation on areas protected from grazing, and

Assignment: ~~G. W. Craddock, Jr., and Kenneth Pearse.~~

Continue on page 79a

R - INT
Special
Erosion & Streamflow
Great Basin

April 1, 1933

Project: The effect of grazing vegetative cover in relation to erosion and streamflow. (This project involves 3 subprojects at present.)

Subproject 1: A study of the effect of plant cover as influenced by overgrazing on surficial run-off and erosion on limestone-clay-shale soil on the Wasatch Plateau.

Scope: To determine (1) the role of herbaceous vegetation in the control of erosion and the regulation of streamflow and (2) the regulation of grazing necessary to maintain adequate watershed protection.

Status: A preliminary study covering early work was published in Department of Agriculture Bulletin 645. Results from 1915 to 1929 inclusive, were published in Technical Bulletin 220. Measurements and recordations have been made and filed since 1929.

Results: The regular measurements were made during the season, including a complete reconnaissance of both erosion areas, recharting and reestimating of quadrats and major plots, enlargement and reestimates of transect plots, mapping of browse species, and the measurement of spring and summer run-off. There were no new developments in the project.

Plans: In studies heretofore, the dissipation of the moisture that entered the soil, evaporation from snow surface and soil factors were not considered. It is planned to continue the project as it is and to supplement it with measurement of soil water losses from bare soil and by transpiration, through the installation of two sets of interception pans, lysimeters and lysiphytometers. An additional triplicate set of small run-off plots will be established to study surficial run-off and erosion in relation to herbaceous cover in a lower elevational zone of the Wasatch Plateau.

Assignment: C. L. Forsling, Milo H, Deming, Ray Price.

R - INT
Special
Erosion and Streamflow
Utah Flood and ErosionSurvey

April 1, 1933

Subproject 2: A survey of recent flood and accelerated erosion areas in Utah.

Scope: Examination of watershed areas in Utah where there has been recent excessive floods or abnormal erosion, for the purpose of determining: (1) The nature and extent of occurrence of abnormal floods and erosion; (2) the contributory causes of such floods and erosion; (3) the possible and practical measures of prevention and control. (4) What further research is advisable for the eventual solution of the watershed protection problem in Utah.

Status: Excessive floods accompanied by heavy erosion of soil occurred in certain localities in Utah, notably in 1923, 1927, 1930, 1931 and 1932. Previously floods have occurred at rather infrequent intervals as far back as 1861. Estimates of flood losses in recent years aggregate several million dollars.

In 1930 an intensive survey was made of the flood areas in Davis County (the area centering about Farmington) the findings of which were published in Circular #92, Utah Agr. Experiment Station, "Torrential Floods in Northern Utah, 1930." In 1931 the field work of an intensive study of all past and potential flood areas on record in the state was begun and continued through the field season of 1932. The findings of this survey are included in a report submitted to the State Land Board of Utah on January 28, 1933, entitled "Report of Utah Flood Survey, 1931-1932." This has not yet been published. The report covers the findings on each of 25 flood areas as to: (1) Location of flood area and watershed, (2) history and nature of floods, (3) pertinent conditions on the watersheds, (4) causes of the floods, (5) ownership of land involved, (6) recommendations for measures to abate floods.

Results: Floods in Utah have occurred generally in the late summer or early autumn following rain storms of torrential character. Exact records of amount and intensity of rainfall are lacking for most of the mountain watersheds. The extent, abundance, and condition of plant cover on the watershed is considered the factor of primary importance in influence on the amount of surface run-off, with physiographic features of secondary importance generally.

In 15 out of 25 cases reported on, depletion of plant cover by overgrazing (to a limited extent by burning) was the chief factor responsible for excessive run-off which produced floods. In 7 cases, naturally

sparse plant cover, in addition to overgrazing, was partly responsible for conditions favorable to excessive run-off. In only 3 cases were steep topography and naturally barren exposures considered to be the chief factors responsible for the production of floods.

Land ownership of the areas involved was determined from records after the field examination was completed. In 16 cases watershed lands were privately controlled or public domain lands, and in 9 cases the watersheds were principally national forest lands and of these 9 cases all but 2 relate back to heavy overgrazing prior to establishment of the national forests.

Recommendations for measures to abate floods were concerned largely with the necessity for improvement of plant cover conditions through regulation and restriction of grazing use, since the function of engineering structures in flood and erosion control is the subject of another report submitted by a different agency.

Recommendations for the development of a watershed protection policy for the state were outlined.

Plans: Field work in the project as planned is completed.

Cooperation: Intermountain Forest & Range Experiment Station, the Utah State Land Board, and the Utah State Agricultural Experiment Station.

Assignment: ~~[illegible]~~, Milo H. Deming.
Reed W. Bailey, Ray J. Becraft - collaborators for the State of Utah.

R - INT
Special
Erosion and Streamflow
Colorado River Watershed Survey

April 1, 1933

Subproject 3: Colorado River watershed survey.

Scope: An extensive survey in the Upper Basin of the Colorado River in Wyoming, Utah, and Colorado for the purpose of securing definite information as to the extent and character of erosion and the apparent effect of erosion on silt load of streams, depletion of range values, and other economic phases of human occupancy and resource development of the entire Colorado River basin, and to determine the need for detailed or localized research as to causes of erosion and the possible means of control or prevention. The area involved is approximately 98,000 square miles.

Status: The field examination started in 1931 was the first systematic attempt to secure definite information on erosion conditions on this watershed, although numerous scattered observations had been made by various workers engaged in different phases of investigation of the natural resources of the region. A preliminary report, "The Erosion Situation on the Watershed of the Upper Basin of the Colorado River" has been submitted. In 1932, field examination was extended to include the Fremont, Escalante and Paria River drainages. A more detailed report covering the complete findings is in preparations, and which is expected to be completed by June 30, 1933.

Results: The generally prevailing conditions of climate, soil, topography, and plant cover over a large portion of the region are such as to be naturally conducive to a high normal rate of erosion. The most recent epicycle of erosional activity is largely coincidental with the time of settlement of the region, and during this time, the rate of erosion has apparently been accelerated to a greater degree than that which has occurred for a long period of time during previous erosion epicycles. It is estimated that 50 percent of the total area is eroding seriously, 27 percent is eroding moderately and 23 percent is eroding lightly. Areas of greatest erosion activity are at medium and lower elevations, have soils of sedimentary origin, semi-arid to arid climatic conditions, and a naturally sparse plant cover which has been subjected to extreme grazing use in more recent years. Excessive erosion and floods are adversely affecting range, irrigation, and power use and development both locally and in the lower basin of the Colorado River. The need is indicated for further research to

determine the relative influence of various factors responsible for accelerated erosion, quantitative determinations of erosion, effect on silt load of streams, and prevention or control measures for its abatement.

Plans: The submission of the detailed report which is contemplated by June 30, 1933, will complete the project planned.

Assignment: ~~xxxxxxxxxxxxxx~~, Milo H. Deming, Jay Higgins (detailed from R-2 in 1931).